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A HISTORY OF THE EARTH, AND ANIMATED NATURE.

IN FOUR VOLUMES.

BY OLIVER GOLDSMITH.

A NEW EDITION.

VOL. I.

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PREFACE.

NATURAL HISTORY, conſidered in its utmoſt extent, comprehends two objects. Firſt, that of diſcovering, aſcertaining, and naming all the various productions of Nature. Secondly, that of deſcribing the properties, manners, and relations which they bear to us, and to each other. The firſt, which is the moſt difficult part of this ſcience, is ſyſtematical, dry, mechanical, and incomplete. The ſecond is more amuſing, exhibits new pictures to the imagination, and improves our reliſh for exiſtence, by widening the proſpect of Nature around us.

Both, however, are neceſſary to thoſe who would underſtand this pleaſing ſcience, in its utmoſt extent. The firſt care of every inquirer, no doubt, ſhould be, to ſee, to viſit, and examine every object, before he pretends to inſpect its habitudes or its hiſtory. From ſeeing and obſerving the thing itſelf, he is moſt naturally led to ſpeculate upon its uſes, its delights, or its inconveniences.

Numberleſs obſtructions, however, are found in this part of his purſuit, that fruſtrate his diligence, and retard his curioſity. The objects in Nature are ſo many, and even thoſe of the ſame kind are exhibited in ſuch a variety of forms, that the inquirer finds himſelf loſt in the exuberance before him, and, like a man who attempts to count the ſtars, unaſſiſted by Art, his powers are all diſtracted in the barren ſuperfluity.

To remedy this embarraſſment, artificial ſyſtems have been deviſed, which grouping into maſſes thoſe parts of Nature more nearly reſembling each other, refer the inquirer for the name of the ſingle object he deſires to know, to ſome one of thoſe general diſtributions, where it is to be found by further examination.

If, for inſtance, a man ſhould, in his walks, meet with an animal, the name, and conſeqnently the hiſtory of which, he deſires to know, he is taught by ſyſtematic writers of natural hiſtory, to examine its moſt obvious qualities, whether a quadruped, a bird, a fiſh, or an inſect. Having determined it, for explanation ſake, to be an inſect, he examines whether it has wings; if he finds it poſſeſſed of theſe, he is taught to examine whether it has two or four; if poſſeſſed of four, he is taught to obſerve, whether the two upper wings are of a ſhelly hardneſs, and ſerve as caſes to thoſe under them; if he finds the wings compoſed in this manner, he is then taught to pronounce, that this inſect is one of the beetle kind: of the beetle kind, there are three different claſſes, diſtinguiſhed from each other by their feelers; he examines the inſect before him, and finds that the feelers are clavated or knobbed at the ends; of beetles, with feelers thus formed, there are ten kinds; and, among thoſe, he is taught to look for the preciſe name of that which is before him. If, for inſtance, the knob be divided at the ends, and the belly be ſtreaked with white, it is no other than the Dor or the May-bug; an animal, the noxious qualities of which give it a very diſtinguiſhed rank in the hiſtory of the inſect creation. In this manner a ſyſtem of natural hiſtory may, in ſome meaſure, be compared to a dictionary of words. Both are ſolely intended to explain the names of things; but with this difference, that in the dictionary of words we are led from the name of the thing to its definition; whereas in the ſyſtem of natural hiſtory, we are led from the definition to find out the name.

Such are the efforts of writers, who have compoſed their works with great labour and ingenuity, to direct the learner in his progreſs through Nature, and to inform him of the name of every animal, plant, or foſſil ſubſtance, that he happens to meet with; but it would be only deceiving the reader, to conceal the truth, which is, that books alone can never teach him this art in perfection; and the ſolitary ſtudent can never ſucceed. Without a maſter, and a previous knowledge of many of the objects in Nature, his book will only ſerve to confound and diſguſt him. Few of the individual plants or animals, that he may happen to meet with, are in that preciſe ſtate of health, or that exact period of vegetation, from whence their deſcriptions were taken. Perhaps he meets the plant only with leaves, but the ſyſtematic writer has deſcribed it in flower. Perhaps he meets the bird before it has moulted its firſt feathers, while the ſyſtematic deſcription was made in its ſtate of full perfection.—He thus ranges without an inſtructor, confuſed, and with ſickening curioſity from ſubject to ſubject, till at laſt he gives up the purſuit, in the multiplicity of his diſappointments.

Some practice, therefore, much inſtruction, and diligent reading, are requiſite to make a ready and expert naturaliſt, who ſhall be able, even by the help of a ſyſtem, to find out the name of every object he meets with. But when this tedious, though requiſite part of ſtudy is attained, nothing but delight and variety attend the reſt of his journey.—Wherever he travels, like a man in a country where he has many friends, he meets with nothing but acquaintances and allurements in all the ſtages of his way. The mere uninformed ſpectator paſſes on in gloomy ſolitude; but the naturaliſt, in every plant, in every inſect, and every pebble, finds ſomething to entertain his curioſity, and excite his ſpeculation.

From hence it appears, that a ſyſtem may be conſidered as a dictionary in the ſtudy of Nature. The ancients, however, who have all written moſt delightfully on this ſubject, ſeem entirely to have rejected thoſe humble and mechanical helps to ſcience. They contented themſelves with ſeizing upon the great outlines of hiſtory, and paſſing over what was common, as not worth the detail, they only dwelt upon what was new, great, and ſurpriſing, and ſometimes even warmed the imagination at the expence of truth. Such of the moderns as revived this ſcience in Europe, undertook the taſk more methodically, though not in a manner ſo pleaſing. Aldrovandus, Geſner, and Johnſon, ſeemed deſirous of uniting the entertaining and rich deſcriptions of the ancients with the dry and ſyſtematic arrangement, of which they were the firſt projectors. This attempt, however, was extremely imperfect, as the great variety of Nature was, as yet but very inadequately known. Nevertheleſs, by attempting to carry on both objects at once; firſt, of directing us to the name of the thing; and then giving the detail of its hiſtory, they drew out their works into a tedious and unreaſonable length; and thus, mixing incompatible aims, they have left their labours rather to be occaſionally conſulted, than read with delight, by poſterity.

The later moderns, with that good ſenſe which they have carried into every other part of ſcience, have taken a different method in cultivating natural hiſtory. They have been content to give, not only the brevity, but alſo the dry and diſguſting air of a dictionary to their ſyſtems. Ray, Klin, Briſſon, and Linnæus, have had only one aim, that of pointing out the object in Nature, of diſcovering its name, and where it was to be found in thoſe authors that treated of it in a more prolix and ſatisfactory manner. Thus natural hiſtory, at preſent, is carried on in two diſtinct and ſeparate channels, the one ſerving to lead us to the thing, the other conveying the hiſtory of the thing, as ſuppoſing it already known.

The following Natural Hiſtory is written, with only ſuch an attention to ſyſtem as ſerves to remove the reader's embarraſſments, and allure him to proceed. It can make no pretenſions in directing him to the name of every object he meets with; that belongs to works of a very different kind, and written with very different aims. It will fully anſwer my deſign, if the reader, being already poſſeſſed of the name of any animal, ſhall find here a ſhort, though ſatisfactory hiſtory of its habitudes, its ſubſiſtence, its manners, its friendſhips, and hoſtilities. My aim has been to carry on juſt as much method as was ſufficient to ſhorten my deſcriptions by generalizing them, and never to follow order where the art of writing, which is but another name for good ſenſe, informed me that it would only contribute to the reader's embarraſſment.

Still, however, the reader will perceive, that I have formed a kind of ſyſtem in the hiſtory of every part of Animated Nature, directing myſelf by the great obvious diſtinctions that ſhe herſelf ſeems to have made; which, though too few to point exactly to the name, are yet ſufficient to illuminate the ſubject, and remove the reader's perplexity. Mr. Buffon indeed, who has brought greater talents to this part of learning than any other man, has almoſt entirely rejected method in claſſing quadrupeds. This, with great deference to ſuch a character, appears to me running into the oppoſite extreme; and, as ſome moderns have of late ſpent much time, great pains, and ſome learning, all to very little purpoſe, in ſyſtematic arrangement, he ſeems ſo much diſguſted by their trifling, but oſtentatious efforts, that he deſcribes his animals almoſt in the order they happen to come before him. This want of method ſeems to be a fault; but he can loſe little by a criticiſm which every dull man can make, or by an error in arrangement, from which the dulleſt are the moſt uſually free.

In other reſpects, as far as this able philoſopher has gone, I have taken him for my guide. The warmth of his ſtyle, and the brilliancy of his imagination, are inimitable. Leaving him, therefore, without a rival in theſe, and only availing myſelf of his information, I have been content to deſcribe things in my own way; and though many of the materials are taken from him, yet I have added, retrenched, and altered, as I thought proper. It was my intention, at one time, whenever I differed from him, to have mentioned it at the bottom of the page; but this occurred ſo often, that I ſoon found it would look like envy, and might, perhaps, convict me of thoſe very errors which I was wanting to lay upon him. I have, therefore, as being every way his debtor, concealed my diſſent, where my opinion was different but wherever I borrow from him, I take care at the bottom of the page to expreſs my obligations. But though my obligations to this writer are many, they extend but to the ſmalleſt part of the work, as he has hitherto completed only the hiſtory of quadrupeds. I was, therefore, left to my own reading alone, to make out the hiſtory of birds, fiſhes, and inſects, of which the arrangement was ſo difficult, and the neceſſary information ſo widely diffuſed, and ſo obſcurely related when found, that it proved by much the moſt laborious part of the undertaking. Thus having made uſe of Mr. Buffon's lights in the firſt part of the work, I may, with ſome ſhare of confidence, recommend it to the public. But what ſhall I ſay to that part, where I have been entirely left without his aſſiſtance? As I would affect neither modeſty nor confidence, it would be ſufficient to ſay that my reading upon this part of the ſubject has been very extenſive; and that I have taxed my ſcanty circumſtances in procuring books, which are on this ſubject, of all others, the moſt expenſive. In conſequence of this induſtry, I here offer a work to the public, of a kind which has never been attempted in ours, or any other modern language that I know of. The ancients, indeed, and Pliny in particular, have anticipated me in the preſent manner of treating natural hiſtory. Like thoſe hiſtorians who deſcribe the events of a campaign, they have not condeſcended to give the private particulars of every individual that formed the army; they were content with characterizing the generals, and deſcribing their operations, while they left it to meaner hands to carry the muſter-roll. I have followed their manner, rejecting the numerous fables which they adopted, and adding the improvements of the moderns, which are ſo numerous, that they actually make up the bulk of natural hiſtory.

The delight which I found in reading Pliny, firſt inſpired me with the idea of a work of this nature. Having a taſte rather claſſical than ſcientific, and having but little employed myſelf in turning over the dry labours of modern ſyſtem-makers, my earlieſt intention was to tranſlate this agreeable writer, and by the help of a commentary to make my work as amuſing as I could. Let us dignify natural hiſtory never ſo much with the grave appellation of *an uſeful ſcience*, yet ſtill we muſt confeſs that it is the occupation of the idle and the ſpeculative, more than of the buſy and the ambitious part of mankind. My intention, therefore, was to treat what I then conceived to be an idle ſubject, in an idle manner; and not to hedge round plain and ſimple narratives with hard words, accumulated diſtinctions, oſtentatious learning, and diſquiſitions that produced no conviction. Upon the appearance, however, of Mr. Buffon's work, I dropped my former plan, and adopted the preſent, being convinced, by his manner, that the beſt imitation of the ancients was to write from our own feelings, and to imitate Nature.

It will be my chief pride, therefore, if this work may be found an innocent amuſement for thoſe who have nothing elſe to employ them, or who require a relaxation from labour. Profeſſed naturaliſts will, no doubt, find it ſuperficial; and yet I ſhould hope that even theſe will diſcover hints and remarks gleaned from various reading, not wholly trite or elementary. I would wiſh for their approbation. But my chief ambition is to drag up the obſcure and gloomy learning of the cell to open inſpection; to ſtrip it from its garb of auſterity, and to ſhew the beauties of that form, which only the induſtrious and the inquiſitive have been hitherto permitted to approach.

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A

HISTORY OF THE EARTH.

CHAP. I.

A SKETCH OF THE UNIVERSE.

THE world may be conſidered as one vaſt manſion, where man has been admitted to enjoy, to admire, and to be grateful. The firſt deſires of ſavage nature are merely to gratify the importunities of ſenſual appetite, and to neglect the contemplation of things, barely ſatisfied with their enjoyment: the beauties of Nature, and all the wonders of Creation, have but little charms for a being taken up in obviating the wants of the day, and anxious for precarious ſubſiſtence.

Our philoſophers, therefore, who have teſtified ſuch ſurpriſe at the want of curioſity in the ignorant, ſeem not to conſider that they are uſually employed in making proviſions of a more important nature; in providing rather for the neceſſities than the amuſements of life. It is not till our more preſſing wants are ſufficiently ſupplied, that we can attend to the calls of curioſity; ſo that in every age ſcientific refinement has been the lateſt effort of human induſtry.

But human curioſity, though, at firſt, ſlowly excited, being at laſt poſſeſſed of leiſure for indulging its propenſity, becomes one of the greateſt amuſements of life, and gives higher ſatisfactions than what even the ſenſes can afford. A man of this diſpoſition turns all nature into a magnificent theatre, replete with objects of wonder and ſurpriſe, and fitted up chiefly for his happineſs and entertainment: he induſtriouſly examines all things, from the minuteſt inſect to the moſt

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finiſhed animal; and, when his limited organs can no longer make the diſquiſition, he ſends out his imagination upon new inquiries.

Nothing, therefore, can be more auguſt and ſtriking than the idea which his reaſon, aided by his imagination, furniſhes of the univerſe around him. Aſtronomers tell us, that this earth which we inhabit forms but a very minute part in that great aſſemblage of bodies of which the world is compoſed. It is a million of times leſs than the ſun, by which it is enlightened. The planets alſo, which, like it, are ſubordinate to the ſun's influence, exceed the earth one thouſand times in magnitude. Theſe, which were at firſt ſuppoſed to wander in the heavens without any fixed path, and that took their name from their apparent deviations, have long been found to perform their circuits with great exactneſs and ſtrict regularity. They have been diſcovered as forming with our earth a ſyſtem of bodies circulating round the ſun, all obedient to one law, and impelled by one common influence.

Modern philoſophy has taught us to believe, that, when the great Author of Nature began the work of creation, he choſe to operate by ſecond cauſes; and that, ſuſpending the conſtant exertion of his power, he endued matter with a quality by which the univerſal economy of nature might be continued without his immediate aſſiſtance. This quality is called *attraction*; a ſort of approximating influence, which all bodies, whether terreſtrial or celeſtial, are found to poſſeſs; and which in all encreaſes as the quantity of matter in each encreaſes. The ſun, by far the greateſt body in our ſyſtem, is, of conſequence, poſſeſſed of much the greateſt ſhare of this attracting power; and all the planets, of which our earth is one, are, of courſe, entirely ſubject to its ſuperior influence. Were this power, therefore, left uncontrolled by any other, the ſun muſt quickly have attracted all the bodies of our celeſtial ſyſtem to itſelf; but it is equably counteracted by another power of equal efficacy; namely, a progreſſive force which each planet received when it was impelled forward, by the divine Architect, upon its firſt formation. The heavenly bodies of our ſyſtem being thus acted upon by two oppoſing powers; namely, by that of *attraction*, which draws them towards the ſun; and that of *impulſion*, which drives them ſtraight forward into the great void of ſpace; they purſue a track between theſe contrary directions; and each, like a ſtone whirled about in a ſling, obeying two oppoſite forces, circulates round its great centre of heat and motion.

In this manner, therefore, is the harmony of our planetary ſyſtem preſerved. The ſun, in the midſt, gives heat, and light, and circular motion to the planets which ſurround it: Mercury, Venus, the Earth, Mars, Jupiter, and Saturn, perform their conſtant circuits at different diſtances, each taking up a time to complete its revolutions proportioned to the greatneſs of the circle which it is to deſcribe. The leſſer planets alſo, which are attendants upon ſome of the greater, are ſubject to the ſame laws; they circulate with the ſame exactneſs; and are, in the ſame manner, influenced by their reſpective centres of motion.

Beſides thoſe bodies which make a part of our peculiar ſyſtem, and which may be ſaid to reſide within its great circumference; there are others, that frequently come among us, from the moſt diſtant tracts of ſpace, and that ſeem like dangerous intruders upon the beautiful ſimplicity of nature. Theſe are comets, whoſe appearance was once ſo terrible to mankind, and the theory of which is ſo little underſtood at preſent: all we know, is, that their number is much greater than that of the planets; and that, like theſe, they roll in orbits, in ſome meaſure, obedient to ſolar influence. Aſtronomers have endeavoured to calculate the returning periods of many of them; but experience has not, as yet, confirmed the veracity of their inveſtigations: Indeed, who can tell when thoſe wanderers have made their excurſions into other worlds and diſtant ſyſtems, what obſtacles may be found to oppoſe their progreſs, to accelerate their motions, or retard their return?

But what we have hitherto attempted to ſketch, is but a ſmall part of that great fabric in which the Deity has thought proper to manifeſt his wiſdom and omnipotence. There are multitudes of other bodies diſperſed over the face of the heavens that lie too remote for examination: theſe have no motion, ſuch as the planets are found to poſſeſs, and are therefore called *fixed ſtars*; and from their extreme brilliancy, and their immenſe diſtance, philoſophers have been induced to ſuppoſe them to be ſuns reſembling that which enlivens our ſyſtem: As the imagination alſo, once excited, is ſeldom content to ſtop, it has furniſhed each with an attendant ſyſtem of planets belonging to itſelf, and has even induced ſome to deplore the fate of thoſe ſyſtems, whoſe imagined ſuns, which ſometimes happens, have become no longer viſible.

But conjectures of this kind, which no reaſoning can aſcertain, nor experiment reach, are rather amuſing than uſeful. Though we ſee the greatneſs and wiſdom of the Deity in all the ſeeming worlds that ſurround us, it is our chief concern to trace him in that which we inhabit. The examination of the earth, the wonders of its contrivance, the hiſtory of its advantages, or of the ſeeming defects in its formation, are the proper buſineſs of the *natural hiſtorian.* A deſcription of this *earth*, its *animals*, *vegetables*, and *minerals*, is the moſt delightful entertainment the mind can be furniſhed with, as it is the moſt intereſting and uſeful. I would beg leave, therefore, to conclude theſe common-place ſpeculations, with an obſervation, which, I hope, is not entirely ſo.

An uſe, hitherto not much inſiſted upon, that may reſult from the contemplation of celeſtial magnificence, is, that it will teach us to make an allowance for the apparent irregularities we find below. Whenever we can examine the works of the Deity at a proper point of diſtance, ſo as to take in the whole of his deſign, we ſee nothing but uniformity, beauty, and preciſion. The heavens preſent us with a plan, which, though inexpreſſibly magnificent, is yet regular beyond the power of invention. Whenever, therefore, we find any apparent defects in the earth, which we are about to conſider, inſtead of attempting to reaſon ourſelves into an opinion that they are beautiful, it will be wiſer to ſay, that we do not behold them at the proper point of diſtance, and that our eye is laid too cloſe to the objects to take in the regularity of their connexion. In ſhort, we may conclude, that God, who is regular in his great productions, acts with equal uniformity in the little.

CHAP. II.

A SHORT SURVEY OF THE GLOBE, FROM THE LIGHT OF ASTRONOMY AND GEOGRAPHY.

ALL the ſciences are in ſome meaſure linked with each other, and before the one is ended the other begins. In a natural hiſtory, therefore, of the earth, we muſt begin with a ſhort account of its ſituation and form, as given us by aſtronomers and geographers: it will be ſufficient, however, upon this occaſion, juſt to hint to the imagination, what they, by the moſt abſtract reaſonings, have forced upon the underſtanding. The earth which we inhabit is, as has been ſaid before, one of thoſe bodies which circulate in our ſolar ſyſtem; it is placed at an happy middle diſtance from the centre; and even ſeems, in this reſpect, privileged beyond all other planets that depend upon our great luminary for their ſupport. Leſs diſtant from the ſun than Saturn, Jupiter, and Mars, and yet leſs parched up than Venus and Mercury, that are ſituate too near the violence of its power, the earth ſeems in a peculiar manner to ſhare the bounty of the Creator: It is not, therefore, without reaſon that mankind conſider themſelves as the peculiar objects of his providence and regard.

Beſides that motion which the earth has round the ſun, the circuit of which is performed in a year, it has another upon its own axle, which it performs in twenty-four hours. Thus, like a chariot-wheel, it has a compound motion; for while it goes forward on its journey, it is all the while turning upon itſelf. From the firſt of theſe two ariſe the grateful viciſſitude of the ſeaſons; from the ſecond, that of day and night.

It may be alſo readily conceived, that a body thus wheeling in circles will moſt probably be itſelf a ſphere. The earth, beyond all poſſibility of doubt, is found to be ſo. Whenever its ſhadow happens to fall upon the moon, in an eclipſe, it appears to be always circular, in whatever poſition it is projected: and it is eaſy to prove, that a body which in every poſition makes a circular ſhadow, muſt itſelf be round. The rotundity of the earth may be alſo proved from the meeting of two ſhips at ſea: the top-maſts of each are the firſt parts that are diſcovered by both, the under parts being hidden by the convexity of the globe which riſes between them. The ſhips in this inſtance may be reſembled to two men who approach each other on the oppoſite ſides of an hill: their heads will firſt be ſeen, and gradually as they come nearer they will come entirely into view.

However, though the earth's figure is ſaid to be ſpherical, we ought only to conceive it as being nearly ſo. It has been found in the laſt age to be rather flatted at both poles, ſo that its form is commonly reſembled to that of a turnip. The cauſe of this ſwelling of the equator is aſcribed to the greater rapidity of the motion with which the parts of the earth are there carried round; and which, conſequently, endeavouring to fly off, act in oppoſition to central attraction. The twirling of a mop may ſerve as an homely illuſtration; which, as every one has ſeen, ſpreads and grows broader in the middle as it continues to be turned round.

As the earth receives light and motion from the ſun, ſo it derives much of its warmth and power of vegetation from the ſame beneficent ſource. However, the different parts of the globe participate of theſe advantages in very different proportions, and accordingly put on very different appearances; a polar proſpect, and a landſcape at the equator, are as oppoſite in their appearances as in their ſituation.

The polar regions, that receive the ſolar beams in a very oblique direction, and that continue for one half of the year in night, receive but few of the genial comforts that other parts of the world enjoy. Nothing can be more mournful or hideous than the picture which travellers preſent of thoſe wretched regions. The ground*, which is rocky and barren, rears itſelf in every place in lofty mountains and inacceſſible cliffs, and meets the mariner's eye at even forty leagues from ſhore. Theſe precipices, frightful in themſelves, receive an additional horror from being conſtantly covered with ice and ſnow, which daily ſeem to accumulate and to fill all the vallies with encreaſing deſolation. The few rocks and cliffs, that are bare of ſnow, look at a diſtance of a dark brown colour, and quite naked. Upon a nearer approach, however, they are found replete with many different veins of coloured ſtone, and here and there ſpread over with a little earth, and a ſcanty portion of graſs and heath. The internal parts of the country are ſtill more deſolate and deterring. In wandering theſe ſolitudes, ſome plains appear covered with ice, that, at firſt glance, ſeem to promiſe the traveller an eaſy journey*. But theſe are even more formidable and more unpaſſable than the mountains themſelves, being cleft with dreadful chaſms, and every where abounding with pits that threaten certain deſtruction. The ſeas that ſurround theſe inhoſpitable coaſts, are ſtill more aſtoniſhing, being covered with flakes of floating ice, that ſpread like extenſive fields, or that riſe out of the water like enormous mountains. Theſe, which are compoſed of materials as clear and tranſparent as glaſs†, aſſume many ſtrange and phantaſtic appearances. Some of them look like churches or caſtles, with pointed turrets; ſome like ſhips in full ſail; and people have often given themſelves the fruitleſs toil to attempt piloting the imaginary veſſels into harbour. There are ſtill others that appear like large iſlands, with plains valleys, and hills, which often rear their heads two hundred yards above the level of the ſea; and although the height of theſe be amazing, yet their depth beneath is ſtill more ſo; ſome of them being found to ſink three hundred fathom under water.

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* Crantz's Hiſtory of Greenland, p. 3.

The earth preſents a very different appearance at the equator, where the ſun-beams, darting directly downwards, burn up the lighter ſoils into extenſive ſandy deſerts, or quicken all the moiſter tracts with incredible vegetation. In theſe regions, almoſt all the ſame inconveniences are felt from the proximity of the ſun, that in the former were endured from its abſence. The deſerts are entirely barren, except where they are found to produce ſerpents, and that in ſuch quantities, that ſome extenſive plains ſeem almoſt entirely covered with them‡.

It not unfrequently happens alſo that this dry ſoil, which is ſo parched and comminuted by the force of the ſun, riſes with the ſmalleſt breeze of wind; and the ſands being compoſed of parts almoſt as ſmall as thoſe of water, they aſſume a ſimilar appearance, rolling onward in waves like thoſe of a troubled ſea, and overwhelming all they meet with inevitable deſtruction. On the other hand, thoſe tracts which are fertile, teem with vegetation even to a noxious degree. The graſs riſes to ſuch a height as often to require burning; the foreſts are impaſſable from underwoods, and ſo matted above, that even the ſun, fierce as it is, can ſeldom penetrate*. Theſe are ſo thick as ſcarce to be extirpated; for the tops being ſo bound together by the climbing plants that grow round them, though an hundred ſhould be cut at the bottom, yet not one would fall, as they mutually ſupport each other. In theſe dark and tangled foreſts, beaſts of various kinds, inſects in aſtoniſhing abundance, and ſerpents of ſurpriſing magnitude, find a quiet retreat from man, and are ſeldom diſturbed except by each other.

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* Crantz's Hiſtory of Greenland, p. 22.

† Ibid. p. 27. ‡ Adanſon's Deſcription of Senegal.

In this manner the extremes of our globe ſeem equally unfitted for the comforts and conveniences of life; and although the imagination may find an awful pleaſure in contemplating the frightful precipices of Greenland, or the luxurious verdure of Africa, yet true happineſs can only be found in the more moderate climates, where the gifts of Nature may be enjoyed without incurring danger in obtaining them.

It is in the temperate zone, therefore, that all the arts of improving Nature, and refining upon happineſs, have been invented: and this part of the earth is, more properly ſpeaking, the theatre of natural hiſtory. Although there be millions of animals and vegetables in the unexplored foreſts under the line, yet moſt of theſe may for ever continue unknown, as curioſity is there repreſſed by ſurrounding danger. But it is otherwiſe in theſe delightful regions which we inhabit, and where this art has had its beginning. Among us there is ſcarce a ſhrub, a flower, or an inſect, without its particular hiſtory; ſcarce a plant that could be uſeful which has not been propagated; nor a weed that could be noxious which has not been pointed out.

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* Linnæi Amænit. vol. vi. p. 67.

CHAP. III.

A VIEW OF THE SURFACE OF THE EARTH.

When we take a ſlight ſurvey of the ſurface of our globe, a thouſand objects offer themſelves, which, though long known, yet ſtill demand our curioſity. The moſt obvious beauty that every where ſtrikes the eye is the verdant covering of the earth, which is formed by an happy mixture of herbs and trees of various magnitudes and uſes. It has been often remarked that no colour refreſhes the ſight ſo well as green; and it may be added, as a farther proof of the aſſertion, that the inhabitants of thoſe places where the fields are continually white with ſnow, generally become blind long before the uſual courſe of nature.

This advantage, which ariſes from the verdure of the fields, is not a little improved by their agreeable inequalities. There [illegible] ſcarce two natural landſcapes that offer proſpects entirely reſembling each other; their riſings and depreſſions, their hills and vallies, are never entirely the ſame, but always offer ſomething new to entertain and refreſh the imagination.

But to encreaſe the beauties of the face of Nature, the landſcape is enlivened by ſprings and lakes, and interſected by rivulets. Theſe lend a brightneſs to the proſpect; give motion and coolneſs to the air; and, what is much more important, furniſh health and ſubſiſtence to animated Nature.

Such are the moſt obvious and tranquil objects that every where offer: but there are others of a more awful and magnificent kind; the *Mountain* riſing above the clouds, and topt with ſnow; the *River* pouring down its ſides, encreaſing as it runs, and loſing itſelf, at laſt, in the ocean; the *Ocean* ſpreading its immenſe ſheet of waters over one half of the globe, ſwelling and ſubſiding at well-known intervals, and forming a communication between the moſt diſtant parts of the earth.

If we leave thoſe objects that ſeem to be natural to our earth, and keep the ſame conſtant tenor, we are preſented with the great irregularities of Nature. The burning mountain; the abrupt precipice; the unfathomable cavern; the headlong cataract; and the rapid whirlpool.

If we carry our curioſity a little further, and deſcend to the objects immediately below the ſurface of the globe, we ſhall there find wonders ſtill as amazing. We firſt perceive the earth for the moſt part lying in regular beds or layers, every bed growing thicker in proportion as it lies deeper, and its contents more compact and heavy. We ſhall find, almoſt wherever we make our ſubterranean inquiry, an amazing number of ſhells that once belonged to aquatic animals. Here and there, at a diſtance from the ſea, beds of oyſter-ſhells, ſeveral yards thick, and many miles over; ſometimes teſtaceous ſubſtances of various kinds on the tops of mountains, and often in the heart of the hardeſt marble. Theſe, which are dug up by the peaſants, in every country, are regarded with little curioſity; for being ſo very common, they are conſidered as ſubſtances entirely terrene. But it is otherwiſe with the inquirer after Nature, who finds them, not only in ſhape but in ſubſtance, every way reſembling thoſe that are bred in the ſea; and he, therefore, is at a loſs how to account for their removal.

Yet not one part of Nature alone, but all her productions and varieties, become the object of the ſpeculative man's inquiry: he takes different views of Nature from the inattentive ſpectator; and ſcarce an appearance, how common ſoever, but affords matter for his contemplation: he inquires how and why the ſurface of the earth has come to have thoſe riſings and depreſſions which moſt men call natural; he demands in what manner the mountains were formed, and in what conſiſt their uſes; he aſks from whence ſprings ariſe; and how rivers flow round the convexity of the globe; he enters into an examination of the ebbings and flowings, and the other wonders of the deep; he acquaints himſelf with the irregularities of Nature, and will endeavour to inveſtigate their cauſes; by which, at leaſt, he will become better verſed in their hiſtory. The internal ſtructure of the globe becomes an object of his curioſity; and, although his inquiries can fathom but a very little way, yet, if poſſeſſed with a ſpirit of theory, his imagination will ſupply the reſt. He will endeavour to account for the ſituation of the marine foſſils that are found in the earth, and for the appearance of the different beds of which it is compoſed. Theſe have been the inquiries that have ſplendidly employed many of the philoſophers of the laſt and preſent age*; and, to a certain degree, they muſt be ſerviceable. But the worſt of it is, that, as ſpeculations amuſe the writer more than facts, they may be often carried to an extravagant length; and that time may be ſpent in reaſoning upon Nature, which might be more uſefully employed in writing her hiſtory.

Too much ſpeculation in natural hiſtory is certainly wrong; but there is a defect of an oppoſite nature that does much more prejudice; namely, that of ſilencing all inquiry, by alleging the benefits we receive from a thing, inſtead of inveſtigating the cauſe of its production. If I inquire how a mountain came to be formed; ſuch a reaſoner, enumerating its benefits, anſwers, becauſe God knew it would be uſeful. If I demand the cauſe of an earthquake, he finds ſome good produced by it, and alleges that as the cauſe of its exploſion. Thus ſuch an inquirer has conſtantly ſome ready reaſon for every appearance in Nature, which ſerves to ſwell his periods, and give ſplendour to his declamation: every thing about him is, on ſome account or other, declared to be good; and he thinks it preſumption to ſcrutinize into its defects, or to endeavour to imagine how it might be better. Such writers, and there are many ſuch, add very little to the advancement of knowledge; and it is finely remarked by Bacon, that the inveſtigation of final cauſes† is a barren ſtudy; and, like a virgin dedicated to the Deity, brings forth nothing. In fact, thoſe men who want to compel every appearance and every irregularity in Nature into our ſervice, and expatiate on their benefits, combat that very morality which they would ſeem to promote. God has permitted thouſands of natural evils to exiſt in the world, becauſe it is by their intervention that man is capable of moral evil; and he has permitted that we ſhould be ſubject to moral evil, that we might do ſomething to deſerve eternal happineſs, by ſhewing that we had rectitude to avoid it.

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* Buffon, Woodward, Burnet, Whiſton, Kircher, Bourquat, Leibnitz, Steno, Ray, &c.

† Inveſtigatio cauſarum finalium ſterilis eſt, et veluti virgo Deo dedicata nil parit.

CHAP. IV.

A REVIEW OF THE DIFFERENT THEORIES OF THE EARTH.

HUMAN invention has been exercifed for ſeveral ages to account for the various irregularities of the earth. While thoſe philoſophers mentioned in the laſt chapter ſee nothing but beauty, ſymmetry, and order; there are others, who look upon the gloomy ſide of Nature, enlarge on its defects, and ſeem to conſider the earth, on which they tread, as one ſcene of extenſive deſolation *. Beneath its ſurface they obſerve minerals and waters confuſedly jumbled together; its different beds of earth irregularly lying upon each other; mountains riſing from places that once were level †; and hills ſinking into vallies; whole regions ſwallowed by the ſea, and others again riſing out of its boſom: all theſe they ſuppoſe to be but a few of the changes that have been wrought in our globe; and they ſend out Imagination to deſcribe it in its primeval ſtate of beauty.

Of thoſe who have written theories deſcribing the manner of the original formation of the earth, or accounting for its preſent appearances, the moſt celebrated are Burnet, Whiſton, Woodward, and Buffon. As ſpeculation is endleſs, ſo it is not to be wondered that all theſe differ from each other, and give oppoſite accounts of the ſeveral changes, which they ſuppoſe our earth to have undergone. As the ſyſtems of each have had their admirers, it is, in ſome meaſure, incumbent upon the natural hiſtorian to be acquainted, at leaſt, with their out-lines; and, indeed, to know what others have even dreamed, in matters of ſcience, is very uſeful, as it may often prevent us from indulging ſimilar deluſions ourſelves, which we ſhould never have adopted, but becauſe we take them to be wholly our own. However, as entering into a detail of theſe theories, is rather furniſhing a hiſtory of opinions than things, I will endeavour to be as conciſe as I can.

The firſt who formed this amuſement of earth-making into ſyſtem, was the celebrated Thomas Burnet, a man of polite

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* Buffon's ſecond Diſcourſe.

† Senec. Quæſt. lib. vi. cap. 21.

learning and rapid imagination. His *Sacred Theory*, as he calls it, deſcribing the changes which the earth has undergone, or ſhall hereafter undergo, is well known for the warmth with which it is imagined, and the weakneſs with which it is reaſoned; for the elegance of its ſtyle, and the meanneſs of its philoſophy. "The earth," ſays he, "before the deluge, was very differently formed from what it is at preſent: it was at firſt a fluid maſs; a chaos compoſed of various ſubſtances, differing both in denſity and figure: thoſe which were moſt heavy ſunk to the centre, and formed in the middle of our globe an hard ſolid body; thoſe of a lighter nature remained next; and the waters, which were lighter ſtill, ſwam upon its ſurface, and covered the earth on every ſide. The air, and all thoſe fluids which were lighter than water, floated upon this alſo; and in the ſame manner encompaſſed the globe; ſo that between the ſurrounding body of waters, and the circumambient air, there was formed a coat of oil, and other unctuous ſubſtances, lighter than water. However, as the air was ſtill extremely impure, and muſt have carried up with it many of thoſe earthy particles with which it once was intimately blended, it ſoon began to defecate, and to depoſe theſe particles upon the oily ſurface already mentioned, which ſoon uniting together, the earth and oil formed that cruſt, which ſoon became an habitable ſurface, giving life to vegetation, and dwelling to animals."

This imaginary antideluvian abode was very different from what we ſee at preſent. "The earth was light and rich; and formed of a ſubſtance entirely adapted to the feeble ſtate of incipient vegetation: it was an uniform plain, every where covered with verdure; without mountains, without ſeas, or the ſmalleſt inequalities. It had no difference of ſeaſons, for its equator was in the plain of the ecliptic, or, in other words, it turned directly oppoſite to the ſun, ſo that it enjoyed one perpetual and luxuriant ſpring. However, this delightful face of Nature did not long continue the ſame, for, after a time, it began to crack and open in fiſſures; a circumſtance which always ſucceeds when the ſun dries away the moiſture from rich or marſhy ſituations. The crimes of mankind had been for ſome time preparing to draw down the wrath of Heaven; and they, at length, induced the Deity to defer repairing theſe breaches in Nature. Thus the chaſms of the earth every day became wider, and, at length, they penetrated to the great abyſs of waters; and the whole earth, in a manner, fell in. Then enſued a total diſorder in the uniform beauty of the firſt creation, the terrene ſurface of the globe being broken down; as it ſunk the waters guſhed out into its place; the deluge became univerſal; all mankind, except eight perſons, were puniſhed with deſtruction, and their poſterity condemned to toil upon the ruins of deſolated Nature."

It only remains to mention the manner in which he relieves the earth from this univerſal wreck, which would ſeem to be as difficult as even its firſt formation. "Theſe great maſſes of earth falling into the abyſs, drew down with them vaſt quantities alſo of air; and by daſhing againſt each other, and breaking into ſmall parts by the repeated violence of the ſhock, they, at length, left between them large cavities, filled with nothing but air. Theſe cavities naturally offered a bed to receive the influent waters; and in proportion as they filled, the face of the earth became once more viſible. The higher parts of its broken ſurface, now become the tops of the mountains, were the firſt that appeared; the plains ſoon after came forward, and, at length, the whole globe was delivered from the waters, except the places in the loweſt ſituations; ſo that the ocean and the ſeas are ſtill a part of the ancient abyſs that have not had a place to return. Iſlands and rocks are fragments of the earth's former cruſt; kingdoms and continents are larger maſſes of its broken ſubſtance; and all the inequalities that are to be found on the ſurface of the preſent earth, are owing to the accidental confuſion into which both earth and waters were then thrown."

The next theoriſt was Woodward, who, in his Eſſay towards a Natural Hiſtory of the Earth, which was only deſigned to precede a greater work, has endeavoured to give a more rational account of its appearances; and was, in fact, much better furniſhed for ſuch an undertaking than any of his predeceſſors, being one of the moſt aſſiduous naturaliſts of his time. His little book, therefore, contains many important facts, relative to natural hiſtory, although his ſyſtem may be weak and groundleſs.

He begins by aſſerting that all terrene ſubſtances are diſpoſed in beds of various natures, lying horizontally one over the other, ſomewhat like the coats of an onion; that they are replete with ſhells, and other productions of the ſea: theſe ſhells being found in the deepeſt cavities, and on the tops of the higheſt mountains. From theſe obſervations, which are warranted by experience, he proceeds to obſerve, that theſe ſhells and extraneous foſſils are not productions of the earth, but are all actual remains of thoſe animals which they are known to reſemble; that all the beds of the earth lie under each other, in the order of their ſpecific gravity; and that they are diſpoſed as if they had been left there by ſubſiding waters. All theſe aſſertions he affirms with much earneſtneſs, although daily experience contradicts him in ſome of them; particularly we find layers of ſtone often over the lighteſt ſoils, and the ſofteſt earth under the hardeſt bodies. However, having, taken it for granted, that all the layers of the earth are found in the order of their ſpecific gravity, the lighteſt at the top, and the heavieſt next the centre, he conſequently aſſerts, and it will not improbably follow, that all the ſubſtances of which the earth is compoſed, were once in an actual ſtate of diſſolution. This univerſal diſſolution he takes to have happened at the time of the flood. He ſuppoſes that at that time a body of water, which was then in the centre of the earth, uniting with that which was found on the ſurface, ſo far ſeparated the terrene parts as to mix altogether in one fluid maſs; the contents of which afterwards ſinking according to their reſpective gravities, produced the preſent appearances of the earth. Being aware, however, of an objection that foſſil ſubſtances are not found diſſolved, he exempts them from this univerſal diſſolution, and, for that purpoſe, endeavours to ſhew that the parts of animals have a ſtronger coheſion than thoſe of minerals; and that, while even the hardeſt rocks may be diſſolved, bones and ſhells may ſtill continue entire.

So much for Woodward; but of all the ſyſtems which were publiſhed reſpecting the earth's formation, that of Whiſton was moſt applauded, and moſt oppoſed. Nor need we wonder; for being ſupported with all the parade of deep calculation, it awed the ignorant, and produced the approbation of ſuch as would be thought otherwiſe, as it implied a knowledge of abſtruſe learning, to be even thought capable of comprehending what the writer aimed at. In fact, it is not eaſy to diveſt it of its mathematical garb; but thoſe who have had leiſure, have found the reſult of our philoſopher's reaſoning to be thus. He ſuppoſes the earth to have been originally a comet; and he conſiders the hiſtory of the creation, as given us in ſcripture, to have its commencement juſt when it was taken by the hand of the Creator, to be more regularly placed as a planet in our ſolar ſyſtem. Before that time, he ſuppoſes it to have been a globe without beauty or proportion; a world in diſorder; ſubject to all the viciſſitudes which comets endure; ſome of which have been found, at different times, a thouſand times hotter than melted iron; at others, a thouſand times colder than ice. Theſe alternations of heat and cold, continually melting and freezing the ſurface of the earth, he ſuppoſes to have produced, to a certain depth, a chaos entirely reſembling that deſcribed by the poets, ſurrounding the ſolid contents of the earth, which ſtill continued unchanged in the midſt, making a great burning globe of more than two thouſand leagues in diameter. This ſurrounding chaos, however, was far from being ſolid: he reſembles it to a denſe though fluid atmoſphere, compoſed of ſubſtances mingled, agitated, and ſhocked againſt each other; and in this diſorder he deſcribes the earth to have been juſt at the eve of creation.

But upon its orbit being then changed, when it was more regularly wheeled round the ſun, every thing took its proper place; every part of the ſurrounding fluid then fell into a ſituation, in proportion as it was light or heavy. The middle, or central part, which always remained unchanged, ſtill continued ſo, retaining a part of that heat which it received in its primeval approaches towards the ſun; which heat, he calculates, may continue for about ſix thouſand years. Next to this fell the heavier parts of the chaotic atmoſphere, which ſerve to ſuſtain the lighter: but as in deſcending they could not entirely be ſeparated from many watery parts, with which they were intimately mixed, they drew down a part of theſe alſo with them; and theſe could not mount again after the ſurface of the earth was conſolidated: they, therefore, ſurrounded the heavy firſt deſcending parts, in the ſame manner as theſe ſurround the central globe. Thus the entire body of the earth is compoſed moſt internally of a great burning globe; next which is placed an heavy terrene ſubſtance, that encompaſſes it; round which alſo is circumfuſed a body of water. Upon this body of waters, the cruſt of earth on which we inhabit is placed: ſo that, according to him, the globe is compoſed of a number of coats, or ſhells, one within the other, all of different denſities. The body of the earth being thus formed, the air, which is the lighteſt ſubſtance of all, ſurrounded its ſurface; and the beams of the ſun darting through, produced that light which, we are told, firſt obeyed the Creator's command.

The whole economy of the creation being thus adjuſted, it only remained to account for the riſings and depreſſions on the ſurface of the earth, with the other ſeeming irregularities of its preſent appearance. The hills and vallies are conſidered by him as formed by their preſſing upon the internal fluid, which ſuſtains the outward ſhell of earth, with greater or leſs weight: thoſe parts of the earth which are heavieſt, ſink into the ſubjacent fluid more deeply, and become vallies: thoſe that are lighteſt, riſe higher upon the earth's ſurface, and are called mountains.

Such was the face of Nature before the deluge; the earth was then more fertile and populous than it is at preſent; the life of man and animals was extended to ten times its preſent duration; and all theſe advantages aroſe from the ſuperior heat of the central globe, which ever ſince has been cooling. As its heat was then in its full power, the genial principle was alſo much greater than at preſent; vegetation and animal encreaſe were carried on with more vigour; and all Nature ſeemed teeming with the ſeeds of life. But theſe phyſical advantages were only productive of moral evil; the warmth which invigorated the body encreaſed the paſſions and appetites of the mind; and, as man became more powerful, he grew leſs innocent. It was found neceſſary to puniſh his depravity; and all living creatures, except the fiſhes, who living in a cold element were not ſubject to a ſimilitude of guilt, were overwhelmed by the deluge in univerſal deſtruction.

This deluge, which ſimple believers are willing to aſcribe to a miracle, philoſophers have long been deſirous to account for by natural cauſes: they have proved that the earth could never ſupply from any reſervoir towards its centre, nor the atmoſphere by any diſcharge from above, ſuch a quantity of water as would cover the ſurface of the globe to a certain depth over the tops of our higheſt mountains. Where, therefore, was all this water to be found? Whiſton has found enough, and more than a ſufficiency, in the tail of a comet; for he ſeems to allot comets a very active part in the great operations of Nature.

He calculates, with great ſeeming precifion, the year, the month, and the day of the week on which this comet (which has paid the earth ſome viſits ſince, though at a kinder diſtance) involved our globe in its tail. The tail he ſuppoſed to be a vaporous fluid ſubſtance, exhaled from the body of the comet, by the extreme heat of the ſun, and encreaſing in proportion as it approached that great luminary. It was in this that our globe was involved at the time of the deluge; and, as the earth ſtill acted by its natural attraction, it drew to itſelf all the watery vapours which were in the comet's tail; and the internal waters being alſo at the ſame time let looſe, in a very ſhort ſpace the tops of the higheſt mountains were laid under the deep.

The puniſhment of the deluge being thus completed, and all the guilty deſtroyed, the earth, which had been broken by the eruption of the internal waters, was alſo enlarged by the ſame; ſo that upon the comet's receſs, there was found room ſufficient in the internal abyſs for the receſs of the ſuperfluous waters; whither they all retired, and left the earth uncovered, but in ſome reſpects changed, particularly in its figure, which, from being round, was now become oblate. In this univerſal wreck of Nature Noah ſurvived, by a variety of happy cauſes, to re-people the earth, and to give birth to a race of men ſlow in believing ill-imagined theories of the earth.

After ſo many theories of the earth, which had been publiſhed, applauded, anſwered, and forgotten, Mr. Buffon ventured to add one more to the number. This philoſopher was, in every reſpect, better qualified than any of his predeceſſors for ſuch an attempt, being furniſhed with more materials, having a brighter imagination to find new proofs, and a better ſtyle to clothe them in. However, if one ſo ill qualified, as I am, may judge, this ſeems the weakeſt part of his admirable work; and I could wiſh, that he had been content with giving us facts inſtead of ſyſtems; that, inſtead of being a reaſoner, he had contented himſelf with being merely a hiſtorian.

He begins his ſyſtem by making a diſtinction between the firſt part of it and the laſt; the one being founded only on conjecture; the other depending entirely upon actual obſervation. The latter part of his theory may, therefore, be true, though the former ſhould be found erroneous.

"The planets," ſays he, "and the earth among the number, might have been formerly (he only offers this as conjecture) a part of the body of the ſun, and adherent to its ſubſtance. In this ſituation, a comet falling in upon that great body might have given it ſuch a ſhock, and ſo ſhaken its whole frame, that ſome of its particles might have been driven off like ſtreaming ſparkles from red hot iron; and each of theſe ſtreams of fire, ſmall as they were in compariſon of the ſun, might have been large enough to have made an earth as great, nay, many times greater than ours. So that in this manner the planets, together with the globe which we inhabit, might have been driven off from the body of the ſun by an impulſive force: in this manner alſo they would continue to recede from it for ever, were they not drawn back by its ſuperior power of attraction; and thus, by the combination of the two motions, they are wheeled round in circles.

"Being in this manner detached at a diſtance from the body of the ſun, the planets, from having been at firſt globes of liquid fire, gradually became cool. The earth alſo having been impelled obliquely forward, received a rotatory motion upon its axis at the very inſtant of its formation, and this motion being greateſt at the equator, the parts there acting againſt the force of gravity, they muſt have ſwollen out, and given the earth an oblate or flatted figure.

"As to its internal ſubſtance, our globe having once belonged to the ſun, it continues to be an uniform maſs of melted matter, very probably vitrified in its primeval fuſion.

But its ſurface is very differently compoſed. Having been in the beginning heated to a degree equal to, if not greater than what comets are found to ſuſtain; like them it had an atmoſphere of vapours floating round it, and which cooling by degrees, condenſed and ſubſided upon its ſurface. Theſe vapours formed, according to their different denſities, the earth, the water, and the air; the heavier parts falling firſt, and the lighter remaining ſtill ſuſpended."

Thus far our philoſopher is, at leaſt, as much a ſyſtem maker as Whiſton or Burnet; and, indeed, he fights his way with great perſeverance and ingenuity, through a thouſand objections that naturally ariſe. Having, at laſt, got upon the earth, he ſuppoſes himſelf on firmer ground, and goes forward with greater ſecurity. Turning his attention to the preſent appearance of things upon this globe, he pronounces from the view that the whole earth was at firſt under water. This water he ſuppoſes to have been the lighter parts of its former evaporation, which, while the earthy particles ſunk downwards by their natural gravity, floated on the ſurface, and covered it for a conſiderable ſpace of time.

"The ſurface of the earth," ſays he*, "muſt have been in the beginning much leſs ſolid than it is at preſent; and, conſequently, the ſame cauſes which at this day produce but very ſlight changes, muſt then, upon ſo complying a ſubſtance, have had very conſiderable effects. We have no reaſon to doubt but that it was then covered with the waters of the ſea; and that thoſe waters were above the tops of our higheſt mountains, ſince, even in ſuch elevated ſituations, we find ſhells and other marine productions in very great abundance. It appears alſo that the ſea continued for a conſiderable time upon the face of the earth: for as theſe layers of ſhells are found ſo very frequent at ſuch great depths, and in ſuch prodigious quantities, it ſeems impoſſible for theſe to have ſupported their numbers all alive at one time; ſo that they muſt have been brought there by ſucceſſive depoſitions. Theſe ſhells are alſo found in the bodies of the hardeſt rocks, where they could not have been depoſited, all at once, at the time of deluge, or at any ſuch inſtant revolution; ſince that would be to ſuppoſe, that all the rocks in which they are found, were at that inſtant, in a ſtate of diſſolution, which would be abſurd to aſſert. The ſea, therefore, depoſited them whereſoever they are now to be found, and that by ſlow and ſucceſſive degrees.

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* Theorie de la Terre, vol. i. p. 111.

"It will appear, alſo, that the ſea covered the whole earth, from the appearance of its layers, which lying regularly one above the other, ſeem all to reſemble the ſediment formed at different times by the ocean. Hence, by the irregular force of its waves, and its currents driving the bottom into ſand-banks, mountains muſt have been gradually formed within this univerſal covering of waters; and theſe ſucceſſively raiſing their heads above its ſurface, muſt, in time, have formed the higheſt ridges of mountains upon land, together with continents, iſlands, and low grounds, all in their turns. This opinion will receive additional weight by conſidering, that in thoſe parts of the earth where the power of the ocean is greateſt, the inequalities on the ſurface of the earth are higheſt: the ocean's power is greateſt at the equator, where its winds and tides are moſt conſtant; and, in fact, the mountains at the equator are found to be higher than in any other part of the world. The ſea, therefore, has produced the principal changes in our earth: rivers, volcanoes, earthquakes, ſtorms, and rain, having made but ſlight alterations, and only ſuch as have affected the globe to very inconſiderable depths."

This is but a very ſlight ſketch of Mr. Buffon's Theory of the Earth; a theory which he has much more powerfully ſupported, than happily invented; and it would be needleſs to take up the reader's time from the purſuit of truth in the diſcuſſion of plauſibilities. In fact, a thouſand queſtions might be aſked this moſt ingenious philoſopher, which he would not find it eaſy to anſwer; but ſuch is the lot of humanity, that a ſingle Goth can in one day deſtroy the fabric which Cæſars were employed an age in erecting. We might aſk, How mountains, which are compoſed of the moſt compact and ponderous ſubſtances, ſhould be the firſt whoſe parts the ſea began to remove? We might aſk, How foſſil-wood is found deeper even than ſhells? which argues, that trees grew upon the places he ſuppoſes once to have been covered with the ocean. But we hope this excellent man is better employed than to think of gratifying the petulance of Incredulity, by anſwering endleſs objections.

CHAP. V.

OF FOSSIL-SHELLS AND OTHER EXTRANEOUS FOSSILS.

WE may affirm of Mr. Buffon, that which has been ſaid of the chymiſts of old; though he may have failed in attaining his principal aim, of eſtabliſhing a theory, yet he has brought together ſuch a multitude of facts relative to the hiſtory of the earth, and the nature of its foſſil productions, that Curioſity finds ample compenſation, even while it feels the want of conviction.

Before, therefore, I enter upon the deſcription of thoſe parts of the earth, which ſeem more naturally to fall within the ſubject, it will not be improper to give a ſhort hiſtory of thoſe animal productions that are found in ſuch quantities, either upon its ſurface, or at different depths below it. They demand our curioſity; and, indeed, there is nothing in Natural Hiſtory that has afforded more ſcope for doubt, conjecture, and ſpeculation. Whatever depths of the earth we examine, or at whatever diſtance within land we ſeek, we moſt commonly find a number of foſſil-ſhells, which being compared with others from the ſea, of known kinds, are found to be exactly of a ſimilar ſhape and nature*. They are found at the very bottom of quarries and mines, in the retired and inmoſt parts of the moſt firm and ſolid rocks, upon the tops of even the higheſt hills and mountains, as well as in the valleys and plains: and this not in one country alone, but in all places where there is any digging for marble, chalk, or any other terreſtrial matters, that are ſo compact as to fence off the external injuries of the air, and thus preſerve theſe ſhells from decay.

Theſe marine ſubſtances, ſo commonly diffuſed, and ſo generally to be met with, were for a long time conſidered by philoſophers, as productions, not of the ſea, but of the earth. "As we find that ſpars," ſaid they, "always ſhoot into peculiar ſhapes, ſo theſe ſeeming ſnails, cockles, and muſcle-ſhells, are only ſportive forms that Nature aſſumes amongſt others of its mineral varieties: they have the ſhape of fiſh, indeed, but they have always been terreſtrial ſubſtances*."

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* Woodward's Eſſay towards a Natural Hiſtory, p. 16.

With this plauſible ſolution mankind were for a long time content; but, upon cloſer inquiry, they were obliged to alter their opinion. It was found that theſe ſhells had, in every reſpect, the properties of animal, and not of mineral nature. They were found exactly of the ſame weight with their fellow ſhells upon ſhore. They anſwered all the chymical trials in the ſame manner as ſea-ſhells do. Their parts, when diſſolved, had the ſame appearance to view, the ſame ſmell and taſte. They had the ſame effects in medicine, when inwardly adminiſtered; and, in a word, were ſo exactly conformable to marine bodies, that they had all the accidental concretions growing to them, (ſuch as pearls, corals, and ſmaller ſhells) which are found in ſhells juſt gathered on the ſhore. They were, therefore, from theſe conſiderations, again given back to the ſea; but the wonder was, how to account for their coming ſo far from their own natural element upon land †.

As this naturally gave riſe to many conjectures, it is not to be wondered that ſome among them have been very extraordinary. An Italian, quoted by Mr. Buffon, ſuppoſes them to have been depoſited in the earth at the time of the Cruſades, by the pilgrims who returned from Jeruſalem; who gathering them upon the ſea-ſhore, in their return carried them to their different places of habitation. But this conjecturer ſeems to have but a very inadequate idea of their numbers. At Touraine, in France, more than a hundred miles from the ſea, there is a plain of about nine leagues long, and as many broad, from whence the peaſants of the country ſupply themſelves with marl for manuring their lands. They ſeldom dig deeper than twenty feet, and the whole plain is compoſed of the ſame materials, which are ſhells of various kinds, without the ſmalleſt portion of earth between them. Here, then, is a large ſpace, in which are depoſited millions of tons of ſhells, which pilgrims could not have collected, though their whole employment had been nothing elſe. England is furniſhed with its beds, which though not quite ſo extenſive, yet are equally wonderful. "Near Reading, in Berkſhire, for many ſucceeding generations, a continued body of oyſter-ſhells has been found through the whole circumference of five or ſix acres of ground. The foundation of theſe ſhells is an hard rocky chalk; and above this chalk, the oyſter-ſhells lie in a bed of green ſand, upon a level, as nigh as can poſſibly be judged, and about two feet thickneſs*." Theſe ſhells are in their natural ſtate, but they are found alſo petrified, and almoſt in equal abundance † in all the Alpine rocks, in the Pyrenees, on the hills of France, England, and Flanders. Even in all quarries from whence marble is dug, if the rocks be ſpilt perpendicularly downwards, petrified ſhells, and other marine ſubſtances, will be plainly diſcerned.

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* Lowth's Abridgment, Phil. Tranſ. vol. ii. p. 426.

† Woodward, p. 43.

"About a quarter of a mile from the river Medway, in the county of Kent, after the taking off the coping of a piece of ground there, the workmen came to a blue marble, which continued for three feet and a half deep, or more, and then beneath appeared a hard floor, or pavement, compoſed of petrified ſhells crowded cloſely together. This layer was about an inch deep, and ſeveral yards over; and it could be walked upon as upon a beach. Theſe ſtones, of which it was compoſed, (the deſcriber ſuppoſes them to have always been ſtones) were either wreathed as ſnails, or bivalvular like cockles. The wreathed kinds were about the ſize of an hazle-nut, and were filled with a ſtony ſubſtance of the colour of marl; and they themſelves, alſo, till they were waſhed, were of the ſame colour; but when cleaned, they appeared of the colour of bezoar, and of the ſame poliſh. After boiling in water they became whitiſh, and left a chalkineſs upon the fingers‡."

In ſeveral parts of Aſia and Africa, travellers have obſerved theſe ſhells in great abundance. In the mountains of Caſtravan, which lie above the city Barut, they quarry out a white ſtone, every part of which contains petrified fiſhes in great numbers, and of ſurpriſing diverſity. They alſo ſeem to continue in ſuch preſervation, that their fins, ſcales, and all the minuteſt diſtinctions of their make, can be perfectly diſcerned*.

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* Phil. Tranſ. vol. ii. p. 427.

† Buffon, vol. i. p. 407.

‡ Phil. Tranſ. p. 426.

From all theſe inſtances we may conclude, that foſſils are very numerous; and, indeed, independent of their ſituations, they afford no ſmall entertainment to obſerve them as preſerved in the cabinets of the curious. The variety of their kinds is aſtoniſhing. Moſt of the ſea-ſhells which are known, and many others to which we are entirely ſtrangers, are to be ſeen either in their natural ſtate, or in various degrees of petrifaction†. In the place of ſome we have mere ſpar, or ſtone, exactly expreſſing all the lineaments of animals, as having been wholly formed from them. For it has happened, that the ſhells diſſolving by very ſlow degrees, and the matter having nicely and exactly filled all the cavities within, this matter, after the ſhells have periſhed, has preſerved exactly and regularly the whole print of their internal ſurface. Of theſe there are various kinds found in our pits; many of them reſembling thoſe of our own ſhores; and many others that are only to be found on the coaſts of other countries. There are ſome ſhells reſembling thoſe that are never ſtranded upon our coaſts‡, but that always remain in the deep‖: and many more there are which we can aſſimilate with no ſhells that are known amongſt us. But we find not only ſhells in our pits, but alſo fiſhes and corals in great abundance; together with almoſt every ſort of marine production.

It is extraordinary enough, however, that the common red coral, though ſo very frequent at ſea, is ſcarce ſeen in the foſſil world, nor is there any account of its having ever been met with. But to compenſate for this, there are all the kinds of the white coral now known; and many other kinds of that ſubſtance with which we are acquainted. Of animals there are various parts; the vertebræ of whales, and the mouths of leſſer fiſhes; theſe, with teeth alſo of various kinds, are found in the cabinets of the curious; where they receive long Greek names, which it is neither the intention nor the province of this work to enumerate. Indeed, few readers would think themſelves much improved, ſhould I proceed with enumerating the various claſſes of the Conicthyodontes, Polyleptoginglimi, or the Orthoceratites. Theſe names, which mean no great matter when they are explained, may ſerve to guide in the furniſhing a cabinet; but they are of very little ſervice in furniſhing the page of inſtructive hiſtory.

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* Buffon, vol. i. p. 408.

† Hill, p. 645.

‡ Littorales.

‖ Pelagii.

From all theſe inſtances we ſee in what abundance theſe petrifactions are to be found; and, indeed, Mr. Buffon, to whoſe accounts we have added ſome, has not been ſparing in the variety of his quotations, concerning the places where they are moſtly to be found. However, I am ſurpriſed that he ſhould have omitted the mention of one, which, in ſome meaſure, more than any of the reſt, would have ſerved to ſtrengthen his theory. We are informed, by almoſt every traveller*, that has deſcribed the pyramids of Egypt, that one of them is entirely built of a kind of free-ſtone, in which theſe petrified ſhells are found in great abundance. This being the caſe, it may be conjectured, as we have accounts of theſe pyramids among the earlieſt records of mankind, and of their being built ſo long before the age of Herodotus, who lived but fifteen hundred years after the flood, that even the Egyptian prieſts could tell neither the time nor the cauſe of their erection; I ſay it may be conjectured that they were erected but a ſhort time after the flood. It is not very likely, therefore, that the marine ſubſtances found in one of them, had time to be formed into a part of the ſolid ſtone, either during the deluge, or immediately after it; and conſequently, their petrifaction muſt have been before that period. And this is the opinion Mr. Buffon has all along ſo ſtrenuouſly endeavoured to maintain; having given ſpecious reaſons to prove, that ſuch ſhells were laid in the beds where they are now found, not only before the deluge, but even antecedent to the formation of man, at the time when the whole earth, as he ſuppoſes, was buried beneath a covering of waters.

But while there are many reaſons to perſuade us that theſe extraneous foſſils have been depoſited by the ſea, there is one fact that will abundantly ſerve to convince us that the earth was habitable, if not inhabited, before theſe marine ſubſtances came to be thus depoſited. For we find foſſil-trees, which no doubt once grew upon the earth, as deep, and as much in the body of ſolid rocks, as theſe ſhells are found to be. Some of theſe fallen trees alſo, have lain at leaſt as long, if not longer, in the earth, than the ſhells, as they have been found ſunk deep in a marly ſubſtance, compoſed of decayed ſhells and other marine productions. Mr. Buffon has proved that foſſil-ſhells could not have been depoſited in ſuch quantities all at once by the flood; and I think, from the above inſtance, it is pretty plain, that, howſoever they were depoſited, the earth was covered with trees before their depoſition; and, conſequently, that the ſea could not have made a very permanent ſtay. How then ſhall we account for theſe extraordinary appearances in Nature? A ſuſpenſion of all aſſent is certainly the firſt, although the moſt mortifying conduct. For my own part, were I to offer a conjecture, and all that has been ſaid upon this ſubject is but conjecture, inſtead of ſuppoſing them to be the remains of animals belonging to the ſea, I would conſider them rather as bred in the numerous freſh-water lakes that, in primeval times, covered the face of uncultivated Nature. Some of theſe ſhells we know to belong to freſh waters: ſome can be aſſimilated to none of the marine ſhells now known*; why, therefore, may we not as well aſcribe the production of all to freſh waters, where we do not find them, as we do that of the latter to the ſea only, where we never find them? We know that lakes and lands alſo, have produced animals that are now no longer exiſting; why, therefore, might not theſe foſſil productions be among the number? I grant that this is making a very harſh ſuppoſition; but I cannot avoid thinking, that it is not attended with ſo many embarraſſments as ſome of the former, and that it is much eaſier to believe that theſe ſhells were bred in freſh water, than that the ſea had for a long time covered the tops of the higheſt mountains.

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* Haſſelquiſt, Sandys.

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* Hill's Foſſils, p. 641.

CHAP. VI.

OF THE INTERNAL STRUCTURE OF THE EARTH.

HAVING, in ſome meaſure, got free from the regions of conjecture, let us now proceed to a deſcription of the earth as we find it by examination, and obſerve its internal compoſition, as far as it has been the ſubject of experience, or expoſed to human inquiry. Theſe inquiries, indeed, have been carried but to a very little depth below its ſurface, and even in that diſquiſition men have been conducted more by motives of avarice than of curioſity. The deepeſt mine, which is that at Cotteberg in Hungary*, reaches not more than three thouſand feet deep; but what proportion does that bear to the depth of the terreſtrial globe, down to the centre, which is above four thouſand miles? All, therefore, that has been ſaid of the earth, to a deeper degree, is merely fabulous or conjectural: we may ſuppoſe with one, that it is a globe of glaſs †; with another, a ſphere of heated iron ‡; with a third, a great maſs of waters ‖; and with a fourth, one dreadful volcano §; but let us, at the ſame time, ſhew our conſciouſneſs, that all theſe are but ſuppoſitions.

Upon examining the earth, where it has been opened to any depth, the firſt thing that occurs, is the different layers or beds of which it is compoſed: theſe all lying horizontally one over the other like the leaves of a book, and each of them compoſed of materials that encreaſe in weight in proportion as they lie deeper. This is, in general, the diſpoſition of the different materials where the earth ſeems to have remained unmoleſted; but this order is frequently inverted; and we cannot tell whether from its original formation, or from accidental cauſes. Of different ſubſtances, thus diſpoſed, the far greateſt part of our globe conſiſts, from its ſurface downwards to the greateſt depths we ever dig or mine ¶.

The firſt coat that is moſt commonly found at the ſurface, is that light coat of blackiſh mold, which is called, by ſome, *garden-earth*. With this the earth is every where inveſted, unleſs it be waſhed off by rains, or removed by ſome other external violence. This ſeems to have been formed from animal and vegetable bodies decaying, and thus turning into its ſubſtance. It alſo ſerves again as a ſtore-houſe, from whence animal and vegetable Nature are renewed, and thus are all vital bleſſings continued with unceaſing circulation. This earth, however, is not to be ſuppoſed entirely pure, but is mixed up with much ſtony and gravelly matter from the layers lying immediately beneath it. It generally happens, that the ſoil is fertile in proportion to the quantity that this putrified mold bears to the gravelly mixture; and as the former predominates, ſo far is the vegetation upon it more luxuriant. It is this external covering that ſupplies man with all the true riches he enjoys. He may bring up gold and jewels from greater depths; but they are merely the toys of a capricious being; things upon which he has placed an imaginary value, and for which fools alone part with the more ſubſtantial bleſſings of life. "It is this earth," ſays Pliny*, "that, like a kind mother, receives us at our birth, and ſuſtains us when born. It is this alone, of all the elements around us, that is never found an enemy to man. The body of waters deluge him with rains, oppreſs him with hail, and drown him with inundations. The air ruſhes in ſtorms, prepares the tempeſt, or lights up the volcano: but the earth, gentle and indulgent, ever ſubſervient to the wants of man, ſpreads his walks with flowers, and his table with plenty; returns with intereſt every good committed to her care; and, though ſhe produces the poiſon, ſhe ſtill ſupplies the antidote; though conſtantly teized more to furniſh the luxuries of man than his neceſſities, yet, even to the laſt, ſhe continues her kind indulgence, and, when life is over, ſhe piouſly covers his remains in her boſom."

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* Boyle, vol iii. p. 240.

† Buffon.

‡ Whiſton.

‖ Burnet.

§ Kircher.

¶ Woodward, p. 9.

This external and fruitful layer which covers the earth, is, as was ſaid, in a ſtate of continual change. Vegetables, which are naturally fixed and rooted to the ſame place, receive their adventitious nouriſhment from the ſurrounding earth and water: animals, which change from place to place, are ſupported by theſe, or by each other. Both, however, having for a time enjoyed a life adapted to their nature, give back to the earth thoſe ſpoils, which they had borrowed for a very ſhort ſpace, yet ſtill to be quickened again into freſh exiſtence. But the depoſits they make are of very diſſimilar kinds, and the earth is very differently enriched by their continuance. Thoſe countries that have for a long time ſupported men and other animals, having been obſerved to become every day more barren; while, on the contrary, thoſe deſolate places, in which vegetables only are abundantly produced, are known to be poſſeſſed of amazing fertility. "In regions which are uninhabited*," ſays Mr. Buffon, "where the foreſts are not cut down, and where animals do not feed upon the plants, the bed of vegetable earth is conſtantly encreaſing. In all woods, and even in thoſe which are often cut, there is a layer of earth of ſix or eight inches thick, which has been formed by the leaves, branches, and bark, which fall and rot upon the ground. I have frequently obſerved on a Roman way that croſſes Burgundy for a long extent, that there is a bed of black earth, of more than a foot thick, gathered over the ſtony pavement, on which ſeveral trees, of a very conſiderable ſize, are ſupported. This I have found to be nothing elſe than an earth formed by decayed leaves and branches, which have been converted by time into a black ſoil. Now as vegetables draw much more of their nouriſhment from the air and water than they do from the earth, it muſt follow, that in rotting upon the ground, they muſt give more to the ſoil than they have taken from it. Hence, therefore, in woods kept a long time without cutting, the ſoil below encreaſes to a conſiderable depth; and ſuch we actually find the ſoil in theſe American wilds where the foreſts have been undiſturbed for ages. But it is otherwiſe where men and animals have long ſubſiſted; for as they make a conſiderable conſumption of wood and plants, both for firing and other uſes, they take more from the earth than they return to it: it follows, therefore, that the bed of vegetable earth, in an inhabited country, muſt be always diminiſhing; and muſt, at length, reſemble the ſoil of Arabia Petrea, and other provinces of the Eaſt, which having been long inhabited, are now become plains of ſalt and ſand;

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* Plinii Naturalis Hiſtoria, lib. ii. cap. 63.

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* Buffon, vol. i. 353.

the fixed ſalt always remaining while the other volatile parts have flown away."

If from this external ſurface we deſcend deeper, and view the earth cut perpendicularly downwards, either in the banks of great rivers, or ſteepy ſea-ſhores; or, going ſtill deeper, if we obſerve it in quarries or mines, we ſhall find its layers regularly diſpoſed in their proper order. We muſt not expect, however, to find them of the ſame kind or thickneſs in every place, as they differ in different ſoils and ſituations. Sometimes marl is ſeen to be over ſand, and ſometimes under it. The moſt common diſpoſition is, that under the firſt earth is found gravel or ſand, then clay or marl, then chalk or coal, marbles, ores, ſands, gravels, and thus an alternation of theſe ſubſtances, each growing more denſe as it ſinks deeper. The clay, for inſtance, found at the depth of a hundred feet, is uſually more heavy than that found not far from the ſurface. In a well which was dug at Amſterdam, to the depth of two hundred and thirty feet, the following ſubſtances were found in ſucceſſion*; ſeven feet of vegetable earth, nine of turf, nine of ſoft clay, eight of ſand, four of earth, ten of clay, four of earth, ten of ſand, two of clay, four of white ſand, one of ſoft earth, fourteen of ſand, eight of clay mixed with ſand, four of ſea-ſand mixed with ſhells, then a hundred and two feet of ſoft clay, and then thirty-one feet of ſand.

In a well dug at Marly, to the depth of a hundred feet, Mr. Buffon gives us a ſtill more exact enumeration of its layers of earth. "Thirteen of a reddiſh gravel, two of gravel mingled with a vitrifiable ſand, three of ſlime, two of marl, four of marly ſtone, five of marl in duſt mixed with vitrifiable ſand, ſix of very fine vitrifiable ſand, three of earthy marl, three of hard marl, one of gravel, one of eglantine, a ſtone of the hardneſs and grain of marble, one of gravelly marl, one of ſtony marl, one of a coarſer kind of ſtony marl, two of a coarſer kind ſtill, one of vitrifiable ſand mixed with foſſil-ſhells, two of fine gravel, three of ſtony marl, one of coarſe powdered marl, one of ſtone, calcinable like marble, three of grey ſand, two of white ſand, one of red ſand ſtreaked with white, eight of grey ſand with ſhells, three of very fine ſand, three of grit, four of red ſand ſtreaked with white, three of white ſand, and fifteen of reddiſh vitrifiable ſand."

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* Varenius, as quoted by Mr. Buffon, p. 358.

In this manner the earth is every where found in beds over beds; and, what is ſtill remarkable, each of them, as far as it extends, always maintains exactly the ſame thickneſs. It is found alſo, that, as we proceed to conſiderable depths, every layer grows thicker. Thus in the adduced inſtances we might have obſerved, that the laſt layer was fifteen feet thick, while moſt of the others were not above eight, and this might have gone much deeper, for aught we can tell, as before they got through it the workmen ceaſed digging.

Theſe layers are ſometimes very extenſive, and often are found to ſpread over a ſpace of ſome leagues in circumference. But it muſt not be ſuppoſed that they are uniformly continued over the whole globe without any interruption: on the contrary, they are ever, at ſmall intervals, cracked through as it were by perpendicular fiſſures; the earth reſembling, in this reſpect, the muddy bottom of a pond, from whence the water has been dried off by the ſun, and thus gaping in ſeveral chinks, which deſcend in a direction perpendicular to its ſurface. Theſe fiſſures are many times found empty, but oftener cloſed up with adventitious ſubſtances, that the rain, or ſome other accidental cauſes, have conveyed to fill their cavities. Their openings are not leſs different than their contents, ſome being not above half an inch wide, ſome a foot, and ſome ſeveral hundred yards aſunder. Theſe laſt form thoſe dreadful chaſms that are to be found in the Alps, at the edge of which the traveller ſtands dreading to look down at the immeaſurable gulph below. Theſe amazing clefts are well known to ſuch as have paſt theſe mountains, where a chaſm frequently preſents itſelf ſeveral hundred feet deep, and as many over, at the edge of which the way lies. It often happens alſo, that the road leads along the bottom, and then the ſpectator obſerves on each ſide frightful precipices ſeveral hundred yards above him; the ſides of which correſpond ſo exactly with each other, that they evidently ſeem torn aſunder.

But theſe chaſms to be found in the Alps, are nothing to what Ovalle tells us are to be ſeen in the Andes. Theſe amazing mountains, in compariſon of which the former are but little hills, have their fiſſures in proportion to their greatneſs. In ſome places they are a mile wide, and deep in proportion; and there are ſome others, that running underground, in extent reſemble a province.

Of this kind alſo is that cavern called *Eldenhole*, in Derbyſhire; which Dr. Plot tells us, was ſounded by a line of eight and twenty hundred feet, without finding the bottom, or meeting with water: and yet the mouth at the top is not above forty yards over*. This immeaſurable cavern runs perpendicularly downward; and the ſides of it ſeem to tally ſo plainly as to ſhew that they once were united. Thoſe who come to viſit the place, generally procure ſtones to be thrown into its mouth; and theſe are heard for ſeveral minutes, falling and ſtriking againſt the ſides of the cavern, producing a ſound that reſembles diſtant thunder, dying away as the ſtone goes deeper.

Of this kind alſo is that dreadful cavern deſcribed by Ælian; his account of which the reader may not have met with†. "In the country of the Arrian Indians, is to be ſeen an amazing chaſm, which is called, *The Gulph of Pluto*. The depth and the receſſes of this horrid place, are as extenſive as they are unknown. Neither the natives, nor the curious who viſit it, are able to tell how it firſt was made, or to what depths it deſcends. The Indians continually drive thither great multitudes of animals, more than three thouſand at a time, of different kinds, ſheep, horſes, and goats; and, with an abſurd ſuperſtition, force them into the cavity, from whence they never return. Their ſeveral ſounds, however, are heard as they deſcend; the bleating of ſheep, the lowing of oxen, and the neighing of horſes, iſſuing up to the mouth of the cavern. Nor do theſe ſounds ceaſe, as the place is continually furniſhed with a freſh ſupply."

There are many more of theſe dreadful perpendicular fiſſures in different parts of the earth; with accounts of which Kircher, Gaffarellus, and others who have given hiſtories of the wonders of the ſubterranean world, abundantly ſupplied us. The generality of readers, however, will conſider them with leſs aſtoniſhment, when they are informed of their being common all over the earth: that in every field, in every quarry, theſe perpendicular fiſſures are to be found; either ſtill gaping, or filled with matter that has accidentally cloſed their interſtices. The inattentive ſpectator neglects the inquiry, but their being common is partly the cauſe that excites the philoſopher's attention to them; the irregularities of Nature he is often content to let paſs unexamined; but when a conſtant and a common appearance preſents itſelf, every return of the object is a freſh call to his curioſity; and the chink in the next quarry becomes as great a matter of wonder as the chaſm in Elden-hole. Philoſophers have long, therefore, endeavoured to find out the cauſe of theſe perpendicular fiſſures, which our own countrymen, Woodward and Ray, were the firſt that found to be ſo common and univerſal. Mr. Buffon ſuppoſes them to be cracks made by the ſun, in drying up the earth immediately after its emerſion from the deep. The heat of the ſun is very probably a principal cauſe; but it is not right to aſcribe to one only, what we find may be the reſult of many. Earthquakes, ſevere froſts, burſting waters, and ſtorms tearing up the roots of trees, have, in our own times produced them: and to this variety of cauſes, we muſt, at preſent, be content to aſſign thoſe that have happened before we had opportunities for obſervation.

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* Phil. Tranſ. vol. ii. p. 370.

† Ælian Var. Hiſt. lib. xvi. cap. 16.

CHAP. VII.

OF CAVES AND SUBTERRANEOUS PASSAGES THAT SINK, BUT NOT PERPENDICULARLY, INTO THE EARTH.

IN ſurveying the ſubterranean wonders of the globe, beſides thoſe fiſſures that deſcend perpendicularly, we frequently find others that deſcend but a little way, and then ſpread themſelves often to a great extent below the ſurface. Many of theſe caverns, it muſt be confeſſed, may be the production of art and human induſtry; retreats made to protect the oppreſſed, or ſhelter the ſpoiler. The famous labyrinth of Candia, for inſtance, is ſuppoſed to be entirely the work of Art. Mr. Tournefort aſſures us, that it bears the impreſſion of human induſtry, and that great pains have beſtowed upon its formation. The ſtone-quarry of Maeſtricht is evidently made by labour: carts enter at its mouth, and load within, then return and diſcharge their freight into boats that lie on the brink of the river Maeſe. This quarry is ſo large, that forty thouſand people may take ſhelter in it: and it in general ſerves for this purpoſe, when armies march that way; becoming then an impregnable retreat to the people that live thereabout. Nothing can be more beautiful than this cavern, when lighted up with torches; for there are thouſands of ſquare pillars, in large level walks, about twenty feet high; and all wrought with much neatneſs and regularity. In this vaſt grotto there is very little rubbiſh; which ſhews both the goodneſs of the ſtone, and the carefulneſs of the workmen. To add to its beauty, there alſo are in various parts of it, little pools of water, for the convenience of the men and cattle. It is remarkable alſo, that no droppings are ſeen to fall from the roof, nor are the walks any way wet under foot, except in caſes of great rains, where the water gets in by the air-ſhafts. The ſalt mines in Poland are ſtill more ſpacious than theſe. Some of the catacombs, both in Egypt and Italy, are ſaid to be very extenſive. But no part of the world has a greater number of artificial caverns than Spain, which were made to ſerve as retreats to the Chriſtians, againſt the fury of the Moors, when the latter conquered that country. However, an account of the works of Art, does not properly belong to a natural hiſtory. It will be enough to obſerve, that though caverns be found in every country, far the greateſt part of them have been faſhioned only by the hand of Nature. Their ſize is found beyond the power of man to have effected; and their forms but ill adapted to the conveniences of a human habitation. In ſome places, indeed, we find mankind ſtill make uſe of them as houſes; particularly in thoſe countries where the climate is very ſevere*; but in general they are deſerted by every race of meaner animals, except the bat; theſe nocturnal ſolitary creatures are uſually the only inhabitants; and theſe only in ſuch whoſe deſcent is ſloping, or, at leaſt, not directly perpendicular.

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* Phil. Tranſ. vol. ii. p. 368.

There is ſcarce a country in the world without its natural caverns; and many new ones are diſcovered every day. Of thoſe in England, Oakley-hole, the Devil's-hole, and Penpark-hole, have been often deſcribed. The former, which lies on the ſouth ſide of Mendip-hills*, within a mile of the town of Wells, is much reſorted to by travellers. To conceive a juſt idea of this, we muſt imagine a precipice of more than a hundred yards high, on the ſide of a mountain which ſhelves away a mile above it. In this is an opening not very large, into which you enter, going along upon a rocky uneven pavement, ſometimes aſcending, and ſometimes deſcending. The roof of it, as you advance, grows higher; and, in ſome places, is fifty feet from the floor. In ſome places, however, it is ſo low that a man muſt ſtoop to paſs. It extends itſelf in length, about two hundred yards; and from every part of the roof, and the floor, there are formed ſparry concretions of various figures, that by ſtrong imaginations have been likened to men, lions, and organs. At the fartheſt part of this cavern riſes a ſtream of water, well ſtored with fiſh, large enough to turn a mill, and which diſcharges itſelf near the entrance.

Penpark-hole, in Glouceſterſhire, is almoſt as remarkable as the former. Captain Sturmey deſcended into this by a rope, twenty-five fathoms perpendicular, and at the bottom found a very large vault in the ſhape of a horſe-ſhoe. The floors conſiſted of a kind of white ſtone enamelled with lead ore, and the pendent rocks were glazed with ſpar. Walking forward on this ſtony pavement, for ſome time, he came to a great river, twenty fathoms broad, and eight fathoms deep; and having been informed that it ebbed and flowed with the ſea, he remained in this gloomy abode for five hours, to make an exact obſervation. He did not find, however, any alteration whatſoever in its appearance. But his curioſity was ill requited; for it coſt this unfortunate gentleman his life: immediately after his return, he was ſeized with an unuſual and violent headach, which threw him into a fever, of which he died ſoon after.

But of all the ſubterranean caverns now known, the grotto of Antiparos is the moſt remarkable, as well for its extent, as for the beauty of its ſparry incruſtations. This celebrated cavern was firſt diſcovered by one Magni, an Italian traveller, about a hundred years ago, at Antiparos, an inconſiderable iſland of the Archipelago*. The account he gives of it is long and inflated, but upon the whole amuſing. "Having been informed," ſays he, "by the natives of Paros, that in the little iſland of Antiparos, which lies about two miles from the former, of a gigantic ſtatue that was to be ſeen at the mouth of a cavern in that place, it was reſolved that we (the French conſul and himſelf) ſhould pay it a viſit. In purſuance of this reſolution, after we had landed on the iſland, and walked about four miles through the midſt of beautiful plains, and ſloping woodlands, we at length came to a little hill, on the ſide of which yawned a moſt horrid cavern, that with its gloom at firſt ſtruck us with terror, and almoſt repreſt curioſity. Recovering the firſt ſurpriſe, however, we entered boldly; and had not proceeded above twenty paces, when the ſuppoſed ſtatue of the giant preſented itſelf to our view. We quickly perceived, that what the ignorant natives had been terrified at as a giant, was nothing more than a ſparry concretion, formed by the water dropping from the roof of the cave, and by degrees hardening into a figure that their fears had formed into a monſter. Incited by this extraordinary appearance, we were induced to proceed ſtill farther, in queſt of new adventures in this ſubterranean abode. As we proceeded, new wonders offered themſelves; the ſpars, formed into trees and ſhrubs, preſented a kind of petrified grove; ſome white, ſome green; and all receding in due perſpective. They ſtruck us with the more amazement, as we knew them to be mere productions of Nature, who, hitherto in ſolitude, had, in her playful moments, dreſſed the ſcene, as if for her own amuſement.

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* Phil. Tranſ. vol. ii. p. 368.

"But we had as yet ſeen but a few of the wonders of the place; and were introduced only into the portico of this amazing temple. In one corner of this half-illuminated receſs, there appeared an opening of about three feet wide, which ſeemed to lead to a place totally dark, and that one of the natives aſſured us contained nothing more than a reſervoir of water. Upon this we tried, by throwing down ſome ſtones, which rumbling along the ſides of the deſcent for ſome time, the ſound ſeemed at laſt quaſhed in a bed of water. In order, however, to be more certain, we ſent in a Levantine mariner, who, by the promiſe of a good reward, with a flambeaux in his hand, ventured into this narrow aperture. After continuing within it for about a quarter of an hour, he returned, carrying ſome beautiful pieces of white ſpar in his hand, which Art could neither imitate nor equal. Upon being informed by him that the place was full of theſe beautiful incruſtations, I ventured in once more with him, for about fifty paces, anxiouſly and cautiouſly deſcending by a ſteep and dangerous way. Finding, however, that we came to a precipice which led into a ſpacious amphitheatre, if I may ſo call it, ſtill deeper than any other part, we returned, and being provided with a ladder, flambeaux, and other things to expedite our deſcent, our whole company, man by man, ventured into the ſame opening, and deſcending one after another, we at laſt ſaw ourſelves all together in the moſt magnificent part of the cavern.

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* Kircher Mund. ſub. 122. I have tranſlated a part of Kircher's deſcription, rather than Tournefort's, as the latter was written to ſupport an hypotheſis.

"Our candles being now all lighted up, and the whole place completely illuminated, never could the eye be preſented with a more glittering, or a more magnificent ſcene. The roof all hung with ſolid iſicles, tranſparent as glaſs, yet ſolid as marble. The eye could ſcarce reach the lofty and noble cieling; the ſides were regularly formed with ſpars; and the whole preſented the idea of a magnificent theatre, illuminated with an immenſe profuſion of lights. The floor conſiſted of ſolid marble; and in ſeveral places, magnificent columns, thrones, altars, and other objects appeared, as if Nature had deſigned to mock the curioſities of Art. Our voices, upon ſpeaking or ſinging, were redoubled to an aſtoniſhing loudneſs; and upon the firing of a gun, the noiſe and reverberations were almoſt deafening. In the midſt of this grand amphitheatre roſe a concretion of about fifteen feet high, that, in ſome meaſure, reſembled an altar; from which, taking the hint, we cauſed maſs to be celebrated there. The beautiful columns that ſhot up round the altar, appeared like candleſticks; and many other natural objects repreſented the cuſtomary ornaments of this ſacrament.

"Below even this ſpacious grotto there ſeemed another cavern; down which I ventured with my former mariner, and deſcended about fifty paces by means of a rope. I at laſt arrived at a ſmall ſpot of level ground, where the bottom appeared different from that of the amphitheatre, being compoſed of ſoft clay, yielding to the preſſure, and in which I thruſt a ſtick to about ſix feet deep. In this, however, as above, numbers of the moſt beautiful cryſtals were formed; one of which particularly reſembled a table. Upon our egreſs from this amazing cavern, we perceived a Greek inſcription upon a rock at the mouth, but ſo obliterated by time, that we could not read it. It ſeemed to import that one Antipater, in the time of Alexander, had come thither; but whether he had penetrated into the depths of the cavern, he does not think fit to inform us."

Such is the account of this beautiful ſcene, as communicated in a letter to Kircher. We have another, and a more copious deſcription of it by Tournefort, which is in every body's hands; but I have given the above, both becauſe it was communicated by the firſt diſcoverer, and becauſe it is a ſimple narrative of facts, without any reaſoning upon them. According to Tournefort's account, indeed, we might conclude, from the rapid growth of the ſpars in this grotto, that it muſt every year be growing narrower, and that it muſt, in time, be choaked up with them entirely; but no ſuch thing has happened hitherto, and the grotto at this day continues as ſpacious as we ever knew it.

This is not the place for an inquiry into the ſeeming vegetation of thoſe ſtony ſubſtances with which this and almoſt every cavern are incruſted; it is enough to obſerve, in general, that they are formed by an accumulation of that little gritty matter, which is carried thither by the waters, and which in time acquires the hardneſs of marble. What in this place more imports us to know is, how theſe amazing hollows in the earth came to be formed. And I think, in the three inſtances above-mentioned, it is pretty evident, that their excavation has been owing to water. Theſe finding ſubterraneous paſſages under the earth, and by long degrees hollowing the beds in which they flowed, the ground above them has ſlipt down cloſer to their ſurface, leaving the upper layers of the earth or ſtone ſtill ſuſpended. The ground that ſinks upon the face of the waters forming the floor of the cavern; the ground, or rock that keeps ſuſpended, forming the roof: And, indeed, there are but few of theſe caverns found without water, either within them, or near enough to point out their formation.

CHAP. VIII.

OF MINES, DAMPS, AND MINERAL VAPOURS.

THE caverns, which we have been deſcribing, generally carry us but a very little way below the ſurface of the earth. Two hundred feet at the utmoſt, is as much as the loweſt of them is found to ſink. The perpendicular fiſſures run much deeper; but few perſons have been bold enough to venture down to their deepeſt receſſes; and ſome few who have tried, have been able to bring back no tidings of the place, for unfortunately they left their lives below. The excavations of Art have conducted us much further into the bowels of the globe. Some mines in Hungary are known to be a thouſand yards perpendicular downwards; and I have been informed, by good authority, of a coal mine in the north of England, an hundred yards deeper ſtill.

It is beſide our preſent purpoſe to inquire into the peculiar conſtruction and contrivance of theſe, which more properly belongs to the hiſtory of foſſils. It will be ſufficient to obſerve in this place, that as we deſcend into the mines, the various layers of earth are ſeen, as we have already deſcribed them; and in ſome of theſe are always found the metals or minerals, for which the mine has been dug. Thus frequently gold is found diſperſed and mixed with clay and gravel*; ſometimes it is mixed with other metallic bodies, ſtones, or bitumens; and † ſometimes united with that moſt obſtinate of all ſubſtances, platina, from which ſcarce any art can ſeparate it. Silver is ſometimes found quite pure*, ſometimes mixed with other ſubſtances and minerals. Copper is found in beds mixed with various ſubſtances, marbles, ſulphurs, and pyrites. Tin the ore of which is heavier than that of any other metal, is generally found mixed with every kind of matter†: lead is alſo equally common, and iron we well know can be extracted from all the ſubſtances upon earth.

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* Ulloa, vol. ii. p. 470.

† Ulloa, ibid.

The variety of ſubſtances which are thus found in the bowels of the earth, in their native ſtate have a very different appearance from what they are afterwards taught to aſſume by human induſtry. The richeſt metals are very often leſs glittering and ſplendid than the moſt uſeleſs marcaſites, and the baſeſt ores, are in general the moſt beautiful to the eye.

This variety of ſubſtances, which compoſe the internal parts of our globe, is productive of equal varieties, both above and below its ſurface. The combination of the different minerals with each other, the heats which ariſe from their mixture, the vapours they diffuſe, the fires which they generate, or the colds which they ſometimes produce, are all either noxious or ſalutary to man; ſo that in this great elaboratory of Nature, a thouſand benefits and calamities are forging, of which we are wholly unconſcious; and it is happy for us that we are ſo.

Upon our deſcent into mines of conſiderable depth, the cold ſeems to increaſe from the mouth as we deſcend‡; but after paſſing very low down, we begin, by degrees, to come into a warmer air, which ſenſibly grows hotter as we go deeper, till, at laſt, the labourers can ſcarce bear any covering as they continue working.

This difference in the air was ſuppoſed by Boyle to proceed from magazines of fire that lay nearer the centre, and that diffuſed their heat to the adjacent regions. But we now know that it may be aſcribed to more obvious cauſes. In ſome mines, the compoſition of the earth all around is of ſuch a nature, that upon the admiſſion of water or air, it frequently becomes hot, and often burſts out into eruptions. Beſides this, as the external air cannot readily reach the bottom, or be renewed there, an obſervable heat is perceived below, without the neceſſity of recurring to the central heat for an explanation.

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* Macquer's Chymiſtry, vol. i. p. 316.

† Hill's Foſſils, p. 628.

‡ Boyle, vol. iii. p. 232.

Hence, therefore, there are two principal cauſes of the warmth at the bottom of mines: the heat of the ſubſtances of which the ſides are compoſed; and the want of renovation in the air below. Any ſulphureous ſubſtance mixed with iron, produces a very great heat, by the admiſſion of water. If, for inſtance, a quantity of ſulphur be mixed with a proportionable ſhare of iron filings, and both kneaded together into a ſoft paſte, with water, they will ſoon grow hot, and at laſt produce a flame. This experiment, produced by Art, is very commonly effected within the bowels of the earth by Nature. Sulphurs and irons are intimately blended together, and want only the mixture of water or air to excite their heat; and this, when once raiſed, is communicated to all bodies that lie within the ſphere of their operation. Thoſe beautiful minerals called *marcaſites* and *pyrites*, are often of this compoſition; and wherever they are found, either by imbibing the moiſture of the air, or having been by any means combined with water, they render the mine conſiderably hot*.

The want of freſh air, alſo, at theſe depths, is, as we have ſaid, another reaſon for their being found much hotter. Indeed, without the aſſiſtance of art, the bottom of moſt mines would, from this cauſe be inſupportable. To remedy this inconvenience, the miners are often obliged to ſink, at ſome convenient diſtance from the mouth of the pit, where they are at work, another pit, which joins the former below, and which, in Derbyſhire, is called an *air-ſhaft*. Through this the air circulates; and thus the workmen are enabled to breath freely at the bottom of the place; which becomes, as Mr. Boyle affirms, very commodious for reſpiration; and alſo very temperate as to heat and cold †. Mr. Locke, however, who has left us an account of the Mendip-mines, ſeems to preſent a different picture. "The deſcent into theſe is exceeding difficult and dangerous; for they are not ſunk like wells, perpendicularly, but as the crannies of the rocks happen to run. The conſtant method is to ſwing down by a rope placed under the arms, and clamber along by applying both feet and hands to the ſides of the narrow paſſage. The air is conveyed into them through a little paſſage that runs along the ſides from the top, where they ſet up ſome turfs, on the lee-ſide of the hole, to catch and force it down. Theſe turfs being removed to the windy ſide, or laid over the mouth of the hole, the miners below preſently want breath, and faint; and if ſweet ſmelling flowers chance to be placed there, they immediately loſe their fragrancy, and ſtink like carrion." An air ſo very putrifying can never be very commodious for reſpiration.

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* Kircher Mund. Subt. vol. ii. p. 216.

† Boyle, vol. iii. p. 238.

Indeed, if we examine the complexion of moſt miners, we ſhall be very well able to form a judgment of the unwholſomeneſs of the place where they are confined. Their pale and ſallow looks ſhew how much the air is damaged by paſſing through thoſe deep and winding ways, that are rendered humid by damps, or warmed with noxious exhalations. But although every mine is unwholeſome, all are not equally ſo. Coal-mines are generally leſs noxious than thoſe of tin; tin than thoſe of copper; but of all, none are ſo dreadfully deſtructive as thoſe of quickſilver. At the mines near the village of Idra, nothing can adequately deſcribe the deplorable infirmities of ſuch as fill the hoſpital there; emaciated and crippled, every limb contracted or convulſed, and ſome in a manner tranſpiring quickſilver at every pore. There was one man, ſays Dr. Pope*, who was not in the mines above half a year, and yet whoſe body was ſo impregnated with this mineral, that putting a piece of braſs money in his mouth, or rubbing it between his fingers, it immediately became as white as if it had been waſhed over with quickſilver. In this manner all the workmen are killed ſooner or later; firſt becoming paralytic, and then dying conſumptive: and all this they ſuſtain for the trifling reward of ſevenpence a-day.

But theſe metallic mines are not ſo noxious from their own vapours as from thoſe of the ſubſtances with which the ores are uſually united, ſuch as arſenic, cinnabar, bitumen, or vitriol. From the fumes of theſe, variouſly combined, and kept incloſed, are produced thoſe various damps, that put on ſo many dreadful forms, and are uſually ſo fatal. Sometimes thoſe noxious vapours are perceived by the delightful fragrance of their ſmell*, ſomewhat reſembling the pea-bloſſom in bloom, from whence one kind of damp has its name. The miners are not deceived, however, by its flattering appearances; but as they thus have timely notice of its coming, they avoid it while it continues, which is generally during the whole ſummer ſeaſon. Another ſhews its approach by the burning of the candles, which ſeem to collect their flame into a globe of light, and thus gradually leſſen, till they are quite extinguiſhed. From this alſo, the miners frequently eſcape; however, ſuch as have the misfortune to be caught in it, either ſwoon away, and are ſuffocated, or ſlowly recover, in exceſſive agonies. Here alſo is a third, called *the fulminating damp*, much more dangerous than either of the former, as it ſtrikes down all before it like a flaſh of gunpowder, without giving any warning of its approach. But there is ſtill another, more deadly than all the reſt, which is found in thoſe places where the vapour has been long confined, and has been, by ſome accident, ſet free. The air ruſhing out from thence, always goes upon deadly errands; and ſcarce any eſcape to deſcribe the ſymptoms of its operations.

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* Phil. Tranſ. vol. ii. p. 578.

Some colliers in Scotland, working near an old mine that had been long cloſed up, happened, inadvertently, to open a hole into it, from the pit where they were then employed. By great good fortune, they at that time perceived their error, and inſtantly fled for their lives. The next day, however, they were reſolved to renew their work in the ſame pit, and eight of them ventured down, without any great apprehenſions; but they had ſcarce got to the bottom of the ſtairs that led to the pit, but, coming within the vapour, they all inſtantly dropped down dead, as if they had been ſhot.—Amongſt theſe unfortunate poor men, there was one whoſe wife was informed he was ſtified in the mine; and, as he happened to be next the entrance, ſhe ſo far ventured down as to ſee where he lay. As ſhe approached the place, the ſight of her huſband inſpired her with a deſire to reſcue him, if poſſible, from that dreadful ſituation; though a little reflection might have ſhewn her it was then too late. But nothing could deter her; ſhe ventured forward, and had ſcarce touched him with her hand, when the damp prevailed, and the miſguided, but faithful creature fell dead by his ſide.

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* Phil. Tranſ. vol. ii. p. 375.

Thus, the vapours found beneath the ſurface of the earth, are very various in their effects upon the conſtitution: and they are not leſs in their appearances. There are many kinds that ſeemingly are no way prejudicial to health, but in which the workmen breathe freely; and yet in theſe, if a lighted candle be introduced, they immediately take fire, and the whole cavern at once becomes one furnace of flame. In mines, therefore ſubject to damps of this kind, they are obliged to have recourſe to a very peculiar contrivance to ſupply ſufficient light for their operations. This is by a great wheel; the circumference of which is beſet with flints, which ſtriking againſt ſteels placed for that purpoſe at the extremity, a ſtream of fire is produced, which affords light enough, and yet which does not ſet fire to the mineral vapour.

Of this kind are the vapours of the mines about Briſtol: on the contrary, in other mines, a ſingle ſpark ſtruck out from the colliſion of flint and ſteel, would ſet the whole ſhaft in a flame. In ſuch, therefore, every precaution is uſed to avoid a colliſion; the workmen making uſe only of wooden inſtruments in digging; and being cautious before they enter the mine, to take out even the nails from their ſhoes.—Whence this ſtrange difference ſhould ariſe, that the vapours of ſome mines catch fire with a ſpark, and others only with a flame, is a queſtion that we muſt be content to leave in obſcurity, till we know more of the nature both of mineral vapour and of fire. This only we may obſerve, that gunpowder will readily fire with a ſpark, but not with the flame of a candle: on the other hand, ſpirits of wine will flame with a candle, but not with a ſpark; but even here the cauſe of this difference, as yet remains a ſecret.

As from this account of mines, it appears that the internal parts of the globe are filled with vapours of various kinds, it is not ſurpriſing that they ſhould, at different times, reach the ſurface, and there put on various appearances. In fact, much of the ſalubrity, and much of the unwholeſomeneſs of climates and ſoils is to be aſcribed to theſe vapours, which make their way from the bowels of the earth upwards, and refreſh or taint the air with their exhalations. Salt mines being naturally cold*, ſend forth a degree of coldneſs to the external air, to comfort and refreſh it: on the contrary, metallic mines are known, not only to warm it with their exhalations, but often to deſtroy all kinds of vegetation by their volatile corroſive fumes. In ſome mines denſe vapours are plainly perceived iſſuing from their mouths, and ſenſibly warm to the touch. In ſome places, neither ſnow nor ice will continue on the ground that covers a mine; and over others the fields are found deſtitute of verdure†. The inhabitants, alſo, are rendered dreadfully ſenſible of theſe ſubterraneous exhalations, being affected with ſuch a variety of evils proceeding entirely from this cauſe, that books have been profeſſedly written upon this claſs of diſorders.

Nor are theſe vapours which thus eſcape to the ſurface of the earth, entirely unconfined; for they are frequently, in a manner, circumſcribed to a ſpot: the grotto Del Cane, near Naples, is an inſtance of this; the noxious effects of which have made that cavern ſo very famous. This grotto, which has ſo much employed the attention of travellers, lies within four miles of Naples, and is ſituated near a large lake of clear and wholeſome water‡. Nothing can exceed the beauty of the landſcape which this lake affords; being ſurrounded with hills covered with foreſts of the moſt beautiful verdure, and the whole bearing a kind of amphitheatrical appearance.—However, this region, beautiful as it appears, is almoſt entirely uninhabited; the few peaſants that neceſſity compels to reſide there, looking quite conſumptive and ghaſtly, from the poiſonous exhalations that riſe from the earth. The famous grotto lies on the ſide of a hill, near which place a peaſant reſides, who keeps a number of dogs for the purpoſe of ſhewing the experiment to the curious. Theſe poor animals always ſeem perfectly ſenſible of the approach of a ſtranger, and endeavour to get out of the way. However, their attempts being perceived, they are taken and brought to the grotto; the noxious effects of which they have ſo frequently experienced. Upon entering this place, which is a little cave or, hole rather, dug into the hill, about eight feet high, and twelve feet long, the obſerver can ſee no viſible marks of its peſtilential vapour; only to about a foot from the bottom, the wall ſeems to be tinged with a colour reſembling that which is given by ſtagnant waters. When the dog, this poor philoſophical martyr, as ſome have called him, is held above this mark, he does not ſeem to feel the ſmalleſt inconvenience; but when his head is thruſt down lower, he ſtruggles to get free for a little; but in the ſpace of four or five minutes he ſeems to loſe all ſenſation, and is taken out ſeemingly without life. Being plunged in the neighbouring lake, he quickly recovers, and is permitted to run home, ſeemingly without the ſmalleſt injury.

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* Phil. Tranſ. vol. ii. p. 523.

† Boyle, vol. iii. p. 238.

‡ Kircher, Mund. Subt. vol. i. p. 191.

This vapour, which thus for a time ſuffocates, is of the humid kind, as it extinguiſhes a torch and ſullies a looking-glaſs; but there are other vapours perfectly inflammable, and that only require the approach of a candle to ſet them blazing. Of this kind was the burning well at Broſely, which is now ſtopped up; the vapour of which, when a candle was brought within about a foot of the ſurface of the water, caught flame like ſpirits of wine, and continued blazing for ſeveral hours after. Of this kind, alſo, are the perpetual fires in the kingdom of Perſia. In that province, where the worſhippers of fire hold their chief myſteries, the whole ſurface of the earth, for ſome extent, ſeems impregnated with inflammable vapours. A reed ſtuck into the ground continues to burn like a flambeaux; a hole made beneath the ſurface of the earth, inſtantly becomes a furnace, anſwering all the purpoſes of a culinary fire. There they make lime by merely burying the ſtones in the earth, and watch with veneration the appearances of a flame that has not been extinguiſhed for times immemorial. How different are men in various climates! This deluded people worſhip the vapours as a deity, which, in other parts of the world, are conſidered as one of the greateſt evils.

CHAP. IX.

OF VOLCANOES AND EARTHQUAKES.

MINES and caverns, as we have ſaid, reach but a very little way under the ſurface of the earth, and we have hitherto had no opportunities of exploring farther. Without all doubt, the wonders that are ſtill unknown ſurpaſs thoſe that have been repreſented, as there are depths of thouſands of miles which are hidden from our inquiry. The only tidings we have from thoſe unfathomable regions are by means of volcanoes, thoſe burning mountains that ſeem to diſcharge their materials from the loweſt abyſſes of the earth*. A volcano may be conſidered as a cannon of immenſe ſize, the mouth of which is often near two miles in circumference. From this dreadful aperture are diſcharged torrents of flame and ſulphur, and rivers of melted metal. Whole clouds of ſmoke and aſhes, with rocks of enormous ſize, are diſcharged to many miles diſtance; ſo that the force of the moſt powerful artillery, is but as a breeze agitating a feather in compariſon. In the deluge of fire and melted matter which runs down the ſides of the mountain, whole cities are ſometimes ſwallowed up and conſumed. Thoſe rivers of liquid fire are ſometimes two hundred feet deep; and, when they harden, frequently form conſiderable hills. Nor is the danger of theſe confined to the eruption only; but the force of the internal fire ſtruggling for vent, frequently produces earthquakes through the whole region where the volcano is ſituated. So dreadful have been theſe appearances, that men's terrors have added new horrors to the ſcene, and they have regarded as prodigies, what we know to be the reſult of natural cauſes. Some philoſophers have conſidered them as vents communicating with the fires of the centre, and the ignorant as the mouths of hell itſelf. Aſtoniſhment produces fear, and fear ſuperſtition: the inhabitants of Iceland believe the bellowings of Hecla are nothing elſe but the cries of the damned, and that its eruptions are contrived to increaſe their tortures.

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* Buffon, vol. i. p. 291.

A VOLCANO

But if we regard this aſtoniſhing ſcene of terror with a more tranquil and inquiſitive eye, we ſhall find that theſe conflagrations are produced by very obvious and natural cauſes. We have already been apprized of the various mineral ſubſtances in the boſom of the earth, and their aptneſs to burſt out into flames. Marcaſites and pyrites, in particular, by being humified with water or air, contract this heat, and often endeavour to expand with irreſiſtible exploſion. Theſe, therefore, being, lodged in the depths of the earth, or in the boſom of mountains, and being either waſhed by the accidental influx of waters below, or fanned by air, inſinuating itſelf through perpendicular fiſſures from above, take fire at firſt by only heaving in earthquakes, but at length by burſting through every obſtacle, and making their dreadful diſcharge in a volcano.

Theſe volcanoes are found in all parts of the earth: In Europe there are three that are very remarkable; Ætna in Sicily, Veſuvius in Italy, and Hecla in Iceland. Ætna has been a volcano for ages immemorial. Its eruptions are very violent, and its diſcharge has been known to cover the earth ſixty-eight feet deep. In the year 1537, an eruption of this mountain produced an earthquake through the whole iſland for twelve days, overturned many houſes, and at laſt formed a new aperture, which overwhelmed all within five leagues round. The cinders thrown up were driven even into Italy, and its burnings were ſeen at Malta at the diſtance of ſixty leagues. "There is nothing more awful," ſays Kircher, "than the eruptions of this mountain, nor nothing more dangerous than attempting to examine its appearances, even long after the eruption has ceaſed. As we attempt to clamber up its ſteepy ſides, every ſtep we take upward, the feet ſink back half way. Upon arriving near the ſummit, aſhes and ſnow, with an ill-aſſorted conjunction, preſent nothing but objects of deſolation. Nor is this the worſt, for, as all places are covered over, many caverns are entirely hidden from the ſight, into which if the inquirer happens to fall, he ſinks to the bottom, and meets inevitable deſtruction. Upon coming to the edge of the great crater, nothing can ſufficiently repreſent the tremendous magnificence of the ſcene. A gulph two miles over, and ſo deep that no bottom can be ſeen; on the ſides pyramidical rocks ſtarting out between apertures that emit ſmoke and flame; all this accompanied with a ſound that never ceaſes, louder than thunder, ſtrikes the bold with horror, and the religious with veneration for HIM that has power to control its burnings."

In the deſcriptions of Veſuvius, or Hecla, we ſhall find ſcarce any thing but a repetion of the ſame terrible objects, but rather leſſened, as theſe mountains are not ſo large as the former. The crater of Veſuvius is but a mile acroſs, according to the ſame author; whereas that of Ætna is two. On this particular, however, we muſt place no dependence, as theſe caverns every day alter; being leſſened by the mountains ſinking in at one eruption, and enlarged by the fury of another. It is not one of the leaſt remarkable particulars reſpecting Veſuvius, that Pliny the naturaliſt was ſuffocated in one of its eruptions; for his curioſity impelling him too near, he found himſelf involved in ſmoke and cinders when it was too late to retire; and his companions hardly eſcaped to give an account of the misfortune. It was in that dreadful eruption that the city of Herculaneum was overwhelmed; the ruins of which have been lately diſcovered at ſixty feet diſtance below the ſurface; and, what is ſtill more remarkable, forty feet below the bed of the ſea. One of the moſt remarkable eruptions of this mountain was in the year 1707, which is finely deſcribed by Valetta; a part of whoſe deſcription I ſhall beg leave to tranſlate.

"Toward the latter end of ſummer, in the year 1707, the mount Veſuvius, that had for a long time been ſilent, now began to give ſome ſigns of commotion. Little more than internal murmurs at firſt were heard, that ſeemed to contend within the lowſt depths of the mountain; no flame, nor even any ſmoke was as yet ſeen. Soon after ſome ſmoke appeared by day, and a flame by night, which ſeemed to brighten all the campania. At intervals, alſo, it ſhot off ſubſtances with a ſound very like that of artillery, but which, even at ſo great a diſtance as we were at, infinitely exceeded them in greatneſs. Soon after it began to throw up aſhes, which becoming the ſport of the winds, fell at great diſtances, and ſome many miles. To this ſucceeded ſhowers of ſtones, which killed many of the inhabitants of the valley, but made a dreadful ravage among the cattle. Soon after a torrent of burning matter began to roll down the ſides of the mountain, at firſt with a ſlow and gentle motion, but ſoon with increaſed celerity. The matter thus poured out, when cold, ſeemed, upon inſpection to be of vitrified earth, the whole united into a maſs of more than ſtony hardneſs. But what was particularly obſervable was, that upon the whole ſurface of theſe melted materials, a light ſpongy ſtone ſeemed to float, while the lower body was of the hardeſt ſubſtance, of which our roads are uſually made. Hitherto there were no appearances but what had been often remarked before; but on the third or fourth day, ſeeming flaſhes of lightening were ſhot forth from the mouth of the mountain, with a noiſe far exceeding the loudeſt thunder. Theſe flaſhes, in colour and brightneſs, reſembled what we uſually ſee in tempeſts, but they aſſumed a more twiſted and ſerpentine form. After this followed ſuch clouds of ſmoke and aſhes that the whole city of Naples, in the midſt of the day, was involved in nocturnal darkneſs, and the neareſt friends were unable to diſtinguiſh each other in this frightful gloom. If any perſon attempted to ſtir without torch-light, he was obliged to return, and every part of the city was filled with ſupplications and terror: At length, after a cotinuance of ſome hours, about one o'clock at midnight, the wind blowing from the north, the ſtars began to be ſeen; the heavens, though it was night, began to grow brighter; and the eruptions, after a continuance of fifteen days, to leſſen. The torrent of melted matter was ſeen to extend from the mountain down to the ſhore; the people began to return to their former dwellings, and the whole face of Nature to reſemble its former appearance."

The famous Biſhop Berkley gives an account of one of theſe eruptions in a manner ſomething different from the former*. "In the year 1717, and the middle of April, with much difficulty I reached the top of Mount Veſuvius, in which I ſaw a vaſt aperture full of ſmoke, which hindered me from ſeeing its depth and figure. I heard within that horrid gulph certain extraordinary ſounds, which ſeemed to proceed from the bowels of the mountain; a ſort of mur-

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* Phil. Tranſ. vol. ii. p. 209.

muring, ſighing, daſhing ſound; and, between whiles, a noiſe like that of thunder or cannon, with a clattering like that of tiles falling from the tops of houſes into the ſtreets. Sometimes, as the wind changed, the ſmoke grew thinner, diſcovering a very ruddy flame, and the circumference of the crater ſtreaked with red, and ſeveral ſhades of yellow. After an hour's ſtay, the ſmoke, being moved by the wind, gave us ſhort and partial proſpects of the great hollow; in the flat bottom of which I could diſcern two furnaces almoſt contiguous; that on the left ſeeming about three yards over, glowing with ruddy flame, and throwing up red hot ſtones with a hideous noiſe, which, as they fell back, cauſed the clattering already taken notice of. May 8, in the morning, I aſcended the top of Veſuvius a ſecond time, and found a different face of things. The ſmoke aſcending upright, gave a full proſpect of the crater, which as I could judge, was about a mile in circumference, and a hundred yards deep. A conical mount had been formed ſince my laſt viſit in the middle of the bottom, which I could ſee was made by the ſtones, thrown up and fallen back again into the crater. In this new hill remained the two furnaces already mentioned. The one was ſeen to throw up every three or four minutes, with a dreadful ſound, a vaſt number of red hot ſtones, at leaſt three hundred feet higher than my head, as I ſtood upon the brink; but as there was no wind, they fell perpendicularly back from whence they had been diſcharged. The other was filled with red hot liquid matter, like that in the furnace of a glaſs-houſe; raging and working like the waves of the ſea, with a ſhort abrupt noiſe. This matter would ſometimes boil over, and run down the ſide of the conical hill, appearing at firſt red hot, but changing colour as it hardened and cooled. Had the wind driven in our faces, we had been in no ſmall danger of ſtifling by the ſulphureous ſmoke, or being killed by the maſſes of melted minerals that were ſhot from the bottom. But as the wind was favourable I had an opportunity of ſurveying this amazing ſcene for above an hour and a half together. On the fifth of June, after a horrid noiſe, the mountain was ſeen at Naples to work over; and about three days after its thunders were renewed ſo, that not only the windows in the city, but all the houſes ſhook. From that time it continued to overflow, and ſometimes at night were ſeen columns of fire ſhooting upwards from its ſummit. On the tenth, when all was thought to be over, the mountain again renewed its terrors, roaring and raging moſt violently. One cannot form a juſter idea of the noiſe, in the moſt violent fits of it, than by imagining a mixed ſound made up of the raging of a tempeſt, the murmur of a troubled ſea, and the roaring of thunder and artillery, confuſed all together. Though we heard this at the diſtance of twelve miles yet it was very terrible. I therefore reſolved to approach nearer to the mountain; and, accordingly, three or four of us got into a boat, and were ſet aſhore at a little town, ſituated at the foot of the mountain. From thence we rode about four or five miles, before we came to the torrent of fire that was deſcending from the ſide of the volcano; and here the roaring grew exceeding loud and terrible as we approached. I obſerved a mixture of colours in the cloud, above the crater, green, yellow, red, blue. There was likewiſe a ruddy diſmal light in the air, over the tract where that burning river flowed. Theſe circumſtances, ſet off and augmented by the horror of the night, made a ſcene the moſt uncommon and aſtoniſhing I ever ſaw; which ſtill increaſed as we approached the burning river. Imagine a vaſt torrent of liquid fire, rolling from the top, down the ſide of the mountain, and with irreſiſtible fury bearing down and conſuming vines, olives, and houſes; and divided into different channels, according to the inequalities of the mountain. The largeſt ſtream ſeemed half a mile broad at leaſt, and five miles long. I walked ſo far before my companions up the mountain, along the ſide of the river of fire, that I was obliged to retire in great haſte, the ſulphureous ſteam having ſurpriſed me, and almoſt taken away my breath. During our return, which was about three o'clock in the morning, the roaring of the mountain was heard all the way, while we obſerving it throwing up huge ſpouts of fire and burning ſtones, which, falling, reſembled the ſtars in a rocket. Sometimes I obſerved two or three diſtinct columns of flame, and ſometimes one only that was large enough to fill the whole crater. Theſe burning columns and fiery ſtones, ſeemed to be ſhot a thouſand feet perpendicular above the ſummit of the volcano: and in this manner the mountain continued raging for ſix or eight days after. On the 18th of the ſame month, the whole appearance ended, and the mountain remained perfectly quiet, without any viſible ſmoke or flame."

The matter which is found to roll down from the mouth of all volcanoes in general, reſembles the droſs that is thrown from a ſmith's forge. But it is different, perhaps, in various parts of the globe; for, as we have already ſaid, there is not a quarter of the world that has not its volcanoes. In Aſia, particularly in the iſlands of the Indian Ocean, there are many. One of the moſt famous is that of Albouras, near Mount Taurus, the ſummit of which is continually on fire, and covers the whole adjacent country with aſhes. In the iſland of Ternate there is a volcano, which ſome travellers aſſert, burns moſt furiouſly in the times of the equinoxes, becauſe of the winds which then contribute to increaſe the flames. In the Molucca iſlands there are many burning mountains; they are alſo ſeen in Japan, and the iſlands adjacent; and in Java and Sumatra, as well as in other of the Philippine Iſlands. In Africa there is a cavern, near Fez, which continually ſends forth either ſmoke or flames. In the Cape de Verde iſlands, one of them called *the Iſland del Fuego*, continually burns; and the Portugueſe, who frequently attempted a ſettlement there, have as often been obliged to deſiſt. The Peak of Teneriff is, as every body knows, a volcano that ſeldom deſiſts from eruptions. But of all parts of the earth, America is the place where thoſe dreadful irregularities of Nature are the moſt conſpicuous. Veſuvius, and Ætna itſelf, are but mere fire-works in compariſon to the burning mountains of the Andes; which, as they are the higheſt mountains of the world, ſo alſo are they the moſt formidable for their eruptions. The mountain of Arequipa in Peru, is one of the moſt celebrated; Taraſſa, and Malahallo, are very conſiderable; but that of Cotopaxi, in the province of Quito, exceeds any thing we have hitherto read or heard of. The mountain of Cotopaxi, as deſcribed by Ulloa*, is more than three miles perpendicular from the ſea; and it became a volcano at the time of the Spaniards' firſt arrival in that country. A new eruption of it happened in the year 1743, having been ſome days preceded by a continual roaring in its bowels. The ſound of one of theſe mountains is not like that of the volcanoes in Europe, confined to a province, but is heard at a hundred and fifty miles diſtance*. "An aperture was made in the ſummit of this immenſe mountain; and three more about equal heights, near the middle of its declivity, which was at that time buried under prodigious maſſes of ſnow. The ignited ſubſtances ejected on that occaſion, mixed with a prodigious quantity of ice and ſnow, melting amidſt the flames, were carried down with ſuch aſtoniſhing rapidity, that in an inſtant the valley from Callo to Latacunga was overflowed; and beſides its ravages in bearing down the houſes of the Indians, and other poor inhabitants, great numbers of people loſt their lives. The river of Latacunga was the channel of this terrible flood; till being too ſmall for receiving ſuch a prodigious current, it overflowed the adjacent country, like a vaſt lake near the town, and carried away all the buildings within its reach. The inhabitants retired into a ſpot of higher ground behind the town, of which thoſe parts which ſtood within the limits of the current were totally deſtroyed. The dread of ſtill greater devaſtations did not ſubſide for three days; during which, the volcano ejected cinders, while torrents of melted ice and ſnow poured down its ſides. The eruption laſted ſeveral days, and was accompanied with terrible roarings of the wind, ruſhing through the volcano, ſtill louder than the former rumblings in its bowels. At laſt all was quiet, neither fire nor ſmoke to be ſeen, nor noiſe to be heard; till in the enſuing year, the flames again appeared with recruited violence, forcing their paſſage through ſeveral other parts of the mountain, ſo that in clear nights the flames being reflected by the tranſparent ice, formed an awfully magnificent illumination."

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* Ulloa, vol. i. p. 442.

Such is the appearance and the effect of thoſe fires which proceed from the more inward receſſes of the earth: for that they generally come from deeper regions than man has hitherto explored, I cannot avoid thinking, contrary to the opinion of Mr. Buffon, who ſuppoſes them rooted but a very little way below the bed of the mountain. "We can never ſuppoſe," ſays this great naturaliſt, "that theſe ſubſtances are ejected from any great diſtance below, if we only conſider the great force already required to fling them up to ſuch vaſt heights above the mouth of the mountain; if we conſider the ſubſtances thrown up, which we ſhall find upon inſpection to be the ſame with thoſe of the mountain below; if we take into our conſideration, that air is always neceſſary to keep up the flame; but, moſt of all, if we attend to one circumſtance, which is, that if theſe ſubſtances were exploded from a vaſt depth below, the ſame force required to ſhoot them up ſo high, would act againſt the ſides of the volcano, and tear the whole mountain in pieces." To all this ſpecious reaſoning, particular anſwers might eaſily be given; as that the length of the funnel increaſes the force of the exploſion; that the ſides of the funnel are actually often burſt with the great violence of the flame; that air may be ſuppoſed at depths at leaſt as far as the perpendicular fiſſures deſcend. But the beſt anſwer is a well-known fact; namely, that the quantity of matter diſcharged from Ætna alone, is ſuppoſed, upon a moderate computation, to exceed twenty times the original bulk of the mountain*. The greateſt part of Sicily ſeems covered with its eruptions. The inhabitants of Catanea have found, at the diſtance of ſeveral miles, ſtreets and houſes ſixty feet deep, overwhelmed by the lava or matter it has diſcharged. But what is ſtill more remarkable, the walls of theſe very houſes have been built of materials evidently thrown up by the mountain. The inference from all this is very obvious; that the matter thus exploded cannot belong to the mountain itſelf; otherwiſe, it would have been quickly conſumed; it cannot be derived from moderate depths, ſince its amazing quantity evinces, that all the places near the bottom muſt have long ſince been exhauſted; nor can it have an extenſive, and, if I may ſo call it, a ſuperficial ſpread, for then the country round would be quickly undermined; it muſt, therefore, be ſupplied from the deeper regions of the earth; thoſe undiſcovered tracts where the Deity performs his wonders in ſolitude, ſatisfied with ſelf-approbation!

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* Ulloa, vol. i. p. 442.

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* Kircher Mund. Subt. vol. i. p. 202.

CHAP. X.

OF EARTHQUAKES.

HAVING given the theory of volcanoes, we have, in ſome meaſure, given alſo that of earthquakes. They both ſeem to proceed from the ſame cauſe, only with this difference, that the fury of the volcano is ſpent in the eruption, that of an earthquake ſpreads wider, and acts more fatally by being confined. The volcano only affrights a province, earthquakes have laid whole kingdoms in ruin.

Philoſophers * have taken ſome pains to diſtinguiſh between the various kinds of earthquakes, ſuch as the tremulous, the pulſative, the perpendicular, and the inclined; but theſe are rather the diſtinctions of Art than of Nature, mere accidental differences ariſing from the ſituation of the country or of the cauſe. If, for inſtance, the confined fire acts directly under a province or a town, it will heave the earth perpendicularly upward, and produce a *perpendicular* earthquake. If it acts at a diſtance, it will raiſe that tract obliquely, and thus the inhabitants will perceive an *inclined* one.

Nor does it ſeem to me that there is much greater reaſon for Mr. Buffon's diſtinction of earthquakes. One kind of which he ſuppoſes† to be produced by fire in the manner of volcanoes, and confined to but a very narrow circumference. The other kind, he aſcribes to the ſtruggles of confined air, expanded by heat in the bowels of the earth, and endeavouring to get free. For how do theſe two cauſes differ? Fire is an agent of no power whatſoever without air. It is the air, which being at firſt compreſſed, and then dilated in a cannon, that drives the ball with ſuch force. It is the air ſtruggling for vent in a volcano, that throws up its contents to ſuch vaſt heights. In ſhort, it is the air confined in the bowels of the earth, and acquiring elaſticity by heat, that produces all thoſe appearances which are generally aſcribed to the operation of fire. When, therefore, we are told that there are two cauſes of earthquakes, we only learn that a greater or ſmaller quantity of heat produces thoſe terrible effects; for air is the only active operator in either.

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* Ariſtotle, Agricola, Buffon.

† Buffon, vol. ii. p. 328.

Some philoſophers, however, have been willing to give the air as great a ſhare in producing theſe terrible effects as they could; and, magnifying its powers, have called in but a very moderate degree of heat to put it in action. Although experience tells us that the earth is full of inflammable materials, and that fires are produced wherever we deſcend; although it tells us that thoſe countries where there are volcanoes are moſt ſubject to earthquakes, yet they ſtep out of their way, and ſo find a new ſolution. Theſe only allow but juſt heat enough to produce the moſt dreadful phenomena, and, backing their aſſertions with long calculations, give theory an air of demonſtration. Mr. Amontons* has been particularly ſparing of the internal heat in this reſpect; and has ſhewn, perhaps accurately enough, that a very moderate degree of heat may ſuffice to give the air amazing powers of expanſion.

It is amazing enough, however, to trace the progreſs of a philoſophical fancy let looſe in imaginary ſpeculations. They run thus: " A very moderate degree of heat may bring the air into a condition capable of producing earthquakes; for the air, at the depth of forty-three thouſand five hundred and twenty-eight fathom below the ſurface of the earth, becomes almoſt as heavy as quickſilver. This, however, is but a very ſlight depth in compariſon of the diſtance to the centre, and is ſcarce a ſeventieth part of the way. The air, therefore, at the centre, muſt be infinitely heavier than mercury, or any body that we know of. This granted, we ſhall take ſomething more and ſay, that it is very probable there is nothing but air at the centre. Now let us ſuppoſe this air heated, by ſome means, even to the degree of boiling water, as we have proved that the denſity of the air is here very great, its elaſticity muſt be in proportion: a heat, therefore, which at the ſurface of the earth would have produced but a ſlight expanſive force, muſt at the centre, produce one very extraordinary, and, in ſhort, be perfectly irreſiſtible. Hence this force may, with great eaſe, produce earthquakes; and, if increaſed, it may convulſe the globe; it may (by only adding figures enough to the calculation) deſtroy the ſolar ſyſtem, and even the fixed ſtars themſelves." Theſe reveries generally produce nothing; for, as I have ever obſerved, increaſed calculations, while they ſeem to tire the memory, give the reaſoning faculty perfect repoſe.

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* Memoires de l'Academie de Sciences, An. 1703.

However, as earthquakes are the moſt formidable miniſters of Nature, it is not to be wondered that a multitude of writers have been curiouſly employed in their conſideration. Woodward has aſcribed the cauſe to a ſtoppage of the waters below the earth's ſurface by ſome accident. Theſe being thus accumulated, and yet acted upon by fires, which he ſuppoſes ſtill deeper, both contribute to heave up the earth upon their boſom. This, he thinks, accounts for the lakes of water produced in an earthquake, as well as for the fires that ſometimes burſt from the earth's ſurface upon thoſe dreadful occaſions. There are others ſtill who have ſuppoſed that the earth may be itſelf the cauſe of its own convulſions. "When," ſay they, "the roots or baſis of ſome large tract is worn away by a fluid underneath, the earth ſinking therein, its weight occaſions a tremor of the adjacent parts, ſometimes producing a noiſe, and ſometimes an inundation of water." Not to tire the reader with a hiſtory of opinions inſtead of facts, ſome have aſcribed them to electricity, and ſome to the ſame cauſes that produce thunder.

It would be tedious, therefore, to give all the various opinions that have employed the ſpeculative upon this ſubject. The activity of the internal heat ſeems alone ſufficient to account for every appearance that attends theſe tremendous irregularities of Nature. To conceive this diſtinctly, let us ſuppoſe at ſome vaſt diſtance under the earth, large quantities of inflammable matter, pyrites, bitumens, and marcaſites diſpoſed, and only waiting for the aſperſion of water, or the humidity of the air, to put their fires in motion: at laſt, this dreadful mixture arrives; waters find their way into thoſe depths, through the perpendicular fiſſures; or air inſinuates itſelf through the ſame minute apertures: inſtantly new appearances enſue: thoſe ſubſtances, which for ages before lay dormant, now conceive new apparent qualities; they grow hot, produce new air, and only want room for expanſion. However, the narrow apertures by which the air or water had at firſt admiſſion, are now cloſed up; yet as new air is continually generated, and as the heat every moment gives this air new elaſticity, it at length burſts, and dilates all round; and, in its ſtruggles to get free, throws all above it into ſimilar convulſions. Thus an earthquake is produced, more or leſs extenſive, according to the depth or the greatneſs of the cauſe.

But before we proceed with the cauſes, let us take a ſhort view of the appearances which have attended the moſt remarkable earthquakes. By theſe we ſhall ſee how far the theoriſt correſponds with the hiſtorian. The greateſt we find in antiquity, is that mentioned by Pliny*, in which twelve cities in Aſia Minor were ſwallowed up in one night: he tells us alſo of another, near the lake Thraſymene, which was not perceived by the armies of the Carthaginians and Romans, that were then engaged near that lake, although it ſhook the greateſt part of Italy. In another place† he gives the following account of an earthquake of an extraordinary kind. "When Lucius Marcus and Sextus Julius were conſuls, there appeared a very ſtrange prodigy of the earth, (as I have read in the books of Ætruſcan diſcipline) which happened in the province of Mutina. Two mountains ſhocked againſt each other, approaching and retiring with the moſt dreadful noiſe. They, at the ſame time, and in the midſt of the day, appeared to caſt forth fire and ſmoke, while a vaſt number of Roman knights and travellers from the Æmilian Way, ſtood and continued amazed ſpectators. Several towns were deſtroyed by this ſhock; and all the animals that were near them were killed." In the time of Trajan, the city of Antioch, and a great part of the adjacent country, was buried by an earthquake. About three hundred years after, in the times of Juſtinian, it was once more deſtroyed, together with forty thouſand inhabitants: and, after an interval of ſixty years, the ſame ill-fated city was a third time overturned, with the loſs of not leſs than ſixty thouſand ſouls. In the year 1182, moſt of the cities of Syria, and the kingdom of Jeruſalem, were deſtroyed by the ſame accident. In the year 1594, the Italian hiſtorians deſcribe an earthquake at Puteoli, which cauſed the ſea to retire two hundred yards from its former bed.

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* Plin. lib. ii. cap. 86. † Ibid. lib. iii. cap. 85.

But one of thoſe moſt particularly deſcribed in hiſtory, is that of the year 1693; the damages of which were chiefly felt in Sicily, but its motion perceived in Germany, France, and England. It extended to a circumference of two thouſand ſix hundred leagues; chiefly affecting the ſea-coaſts, and great rivers; more perceivable alſo upon the mountains than in the valleys. Its motions were ſo rapid, that thoſe who lay at their length, were toſſed from ſide to ſide, as upon a rolling billow*. The walls were daſhed from their foundations; and no leſs than fifty-four cities, with an incredible number of villages, were either deſtroyed or greatly damaged. The city of Catanea, in particular, was utterly overthrown. A traveller, who was on his way thither, at the diſtance of ſome miles, perceived a black cloud, like night, hanging over the place. The ſea, all of a ſudden, began to roar; Mount Ætna to ſend forth great ſpires of flame; and ſoon after a ſhock enſued, with a noiſe as if all the artillery in the world had been at once diſcharged. Our traveller, being obliged to alight inſtantly, felt himſelf raiſed a foot from the ground; and turning his eyes to the city, he, with amazement, ſaw nothing but a thick cloud of duſt in the air. The birds flew about aſtoniſhed; the ſun was darkened; the beaſts ran howling from the hills; and, although the ſhock did not continue above three minutes, yet near nineteen thouſand of the inhabitants of Sicily periſhed in the ruins.—Catanea, to which city the deſcriber was travelling, ſeemed the principal ſcene of ruin; its place only was to be found; and not a footſtep of its former magnificence was to be ſeen remaining.

The earthquake which happened in Jamaica, in 1692, was very terrible, and its deſcription ſufficiently minute. "In two minutes time it deſtroyed the town of Port-Royal, and ſunk the houſes in a gulph forty fathoms deep. It was attended with a hollow rumbling noiſe, like that of thunder; and, in leſs than a minute, three parts of the houſes, and their inhabitants, were all ſunk quite under water. While they were thus ſwallowed up on one ſide of the ſtreet, on the other the houſes were thrown into heaps; the ſand of the ſtreet riſing like the waves of the ſea, lifting up thoſe that ſtood upon it, and immediately overwhelming them in pits. All the wells diſcharged their waters with the moſt vehement agitation. The ſea felt an equal ſhare of turbulence, and, burſting over its mounds, deluged all that came in its way. The fiſſures of the earth were, in ſome places, ſo great, that one of the ſtreets appeared twice as broad as formerly. In many places, however, it opened and cloſed again, and continued this agitation for ſome time. Of theſe openings, two or three hundred might be ſeen at a time; in ſome whereof the people were ſwallowed up; in others, the earth cloſing, caught them by the middle, and thus cruſhed them inſtantly to death. Other openings, ſtill more dreadful than the reſt, ſwallowed up whole ſtreets; and others, more formidable ſtill, ſpouted up whole cataracts of water, drowning ſuch as the earthquake had ſpared. The whole was attended with the moſt noiſome ſtench; while the thundering of the diſtant falling mountains, the whole ſky overcaſt with a duſky gloom, and the craſh of falling habitations, gave unſpeakable horror to the ſcene. After this dreadful calamity was over, the whole iſland ſeemed converted into a ſcene of deſolation; ſcarce a planter's houſe was left ſtanding; almoſt all were ſwallowed up; houſes, people, trees, ſhared one univerſal ruin; and in their places appeared great pools of water, which, when dried up by the ſun, left only a plain of barren ſand, without any veſtige of former inhabitants. Moſt of the rivers, during the earthquake, were ſtopt up by the falling in of the mountains; and it was not till after ſome time that they made themſelves new channels. The mountains ſeemed particularly attacked by the force of the ſhock; and it was ſuppoſed that the principal ſeat of the concuſſion was among them." Thoſe who were ſaved got on board ſhips in the harbour; where many remained above two months, the ſhocks continuing during that interval with more or leſs violence every day."

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* Phil. Tranſ.

As this deſcription ſeems to exhibit all the appearances that uſually make up the catalogue of terrors belonging to an earthquake, I will ſuppreſs the detail of that which happened at Liſbon, in our own times, and which is too recent to require a deſcription. In fact, there are few particulars in the accounts of thoſe who were preſent at that ſcene of deſolation, that we have not more minutely and accurately tranſmitted to us by former writers, whoſe narratives I have for that reaſon preferred. I will therefore cloſe this deſcription of human calamities, with the account of the dreadful earthquake at Calabria, in 1638. It is related by the celebrated Father Kircher, as it happened while he was on his journey to viſit Mount Ætna, and the reſt of the wonders that lie towards the ſouth of Italy. I need ſcarce inform the reader, that Kircher is conſidered, by ſcholars, as one of the greateſt prodigies of learning.

"Having hired a boat, in company with four more, two friars of the order of St. Francis, and two ſeculars, we launched, on the twenty-fourth of March, from the harbour of Meſſina, in Sicily, and arrived the ſame day at the Promontory of Pelorus. Our deſtination was for the city of Euphæmia, in Calabria, where we had ſome buſineſs to tranſact, and where we deſigned to tarry for ſome time. However, Providence ſeemed willing to croſs our deſign; for we were obliged to continue for three days at Pelorus, upon account of the weather; and tho' we often put out to ſea, yet we were as often driven back. At length, however, wearied with the delay, we reſolved to proſecute our voyage; and, although the ſea ſeemed more than uſually agitated, yet we ventured forward. The gulph of Charybdis, which we approached, ſeemed whirled round in ſuch a manner as to form a vaſt hollow, verging to a point in the centre. Proceeding onward, and turning my eyes to Ætna, I ſaw it caſt forth large volumes of ſmoke, of mountainous ſizes, which entirely covered the whole iſland, and blotted out the very ſhores from my view. This, together with the dreadful noiſe, and the ſulphureous ſtench, which was ſtrongly perceived, filled me with apprehenſions that ſome more dreadful calamity was impending. The ſea itſelf ſeemed to wear a very unuſual appearance; thoſe who have ſeen a lake in a violent ſhower of rain covered all over with bubbles, will conceive ſome idea of its agitations. My ſurpriſe was ſtill increaſed by the calmneſs and ſerenity of the weather; not a breeze, not a cloud which might be ſuppoſed to put all Nature thus into motion. I therefore warned my companions that an earthquake was approaching; and, after ſome time, making for the ſhore with all poſſible diligence, we landed at Tropæa, happy and thankful for having eſcaped the threatening dangers of the ſea.

" But our triumphs at land were of ſhort duration; for we had ſcarce arrived at the Jeſuits' College in that city, when our ears were ſtunned with a horrid ſound, reſembling that of an infinite number of chariots driven fiercely forward, the wheels rattling, and the thongs cracking. Soon after this, a moſt dreadful earthquake enſued, ſo that the whole tract upon which we ſtood ſeemed to vibrate, as if we were in the ſcale of a balance that continued wavering. This motion, however, ſoon grew more violent; and being no longer able to keep my legs, I was thrown proſtrate upon the ground.—In the mean time, the univerſal ruin round me redoubled my amazement. The craſh of falling houſes, the tottering of towers, and the groans of the dying, all contributed to raiſe my terror and deſpair. On every ſide of me I ſaw nothing but a ſcene of ruin, and danger threatening wherever I ſhould fly. I commended myſelf to God, as my laſt great refuge. At that hour, O how vain was every ſublunary happineſs! wealth, honour, empire, wiſdom, all mere uſeleſs ſounds, and as empty as the bubbles in the deep. Juſt ſtanding on the threſhold of eternity, nothing but God was my pleaſure; and the nearer I approached, I only loved him the more.—After ſome time, however, finding that I remained unhurt, amidſt the general concuſſion, I reſolved to venture for ſafety, and running as faſt as I could, reached the ſhore, but almoſt terrified out of my reaſon. I did not ſearch long here till I found the boat in which I had landed, and my companions alſo, whoſe terrors were even greater than mine. Our meeting was not of that kind where every one is deſirous of telling his own happy eſcape; it was all ſilence, and a gloomy dread of impending terrors.

" Leaving this ſeat of deſolation, we proſecuted our voyage along the coaſt; and the next day came to Rochetta, where we landed, although the earth ſtill continued in violent agitations. But we were ſcarce arrived at our inn, when we were once more obliged to return to the boat, and in about half an hour, we ſaw the greateſt part of the town, and the inn at which we had ſet up, daſhed to the ground, and burying all its inhabitants beneath its ruins.

" In this manner, proceeding onward in our little veſſel, finding no ſafety at land, and yet, from the ſmallneſs of our boat, having but a very dangerous continuance at ſea, we at length landed at Lopizium, a caſtle midway between Tropæa and Euphæmia, the city to which, as I ſaid before we were bound. Here, wherever I turned my eyes, nothing but ſcenes of ruin and horror appeared; towns and caſtles levelled to the ground; Strombalo, though at ſixty miles diſtance, belching forth flames in an unuſual manner, and with a noiſe which I could diſtinctly hear. But my attention was quickly turned from more remote to contiguous danger. The rumbling ſound of an approaching earthquake, which we by this time were grown acquainted with, alarmed us for the conſequences; it every moment ſeemed to grow louder, and to approach more near. The place on which we ſtood now began to ſhake moſt dreadfully, ſo that being unable to ſtand, my companions and I caught hold of whatever ſhrub grew next us, and ſupported ourſelves in that manner.

" After ſome time, this violent paroxyſm ceaſing, we again ſtood up, in order to proſecute our voyage to Euphæmia, that lay within ſight. In the mean time, while we were preparing for this purpoſe, I turned my eyes towards the city, but could ſee only a frightful dark cloud, that ſeemed to reſt upon the place. This the more ſurpriſed us, as the weather was ſo very ſerene. We waited, therefore, till the cloud was paſt away; then turning to look for the city, it was totally ſunk. Wonderful to tell! nothing but a diſmal and putrid lake was ſeen where it ſtood. We looked about to find ſome one that could tell us of its ſad cataſtrophe, but could ſee none! All was become a melancholy ſolitude! a ſcene of hideous deſolation! Thus proceeding penſively along, in queſt of ſome human being that could give us ſome little information, we at length ſaw a boy ſitting by the ſhore, and appearing ſtupified with terror. Of him, therefore, we inquired concerning the fate of the city, but he could not be induced to give us an anſwer. We intreated him with every expreſſion of tenderneſs and pity to tell us; but his ſenſes were quite wrapt up in contemplation of the danger he had eſcaped. We offered him ſome victuals, but he ſeemed to lothe the ſight. We ſtill perſiſted in our offices of kindneſs; but he only pointed to the place of the city, like one out of his ſenſes; and then running up into the woods, was never heard of after. Such was the fate of the city of Euphæmia! and as we continued our melancholy courſe along the ſhore, the whole coaſt, for the ſpace of two hundred miles, preſented nothing but the remains of cities, and men ſcattered, without a habitation, over the fields. Proceeding thus along, we at length ended our diſtreſsful voyage by arriving at Naples, after having eſcaped a thouſand dangers both at ſea and land."

The reader, I hope, will excuſe me for this long tranſlation from a favourite writer, and that the ſooner, as it contains ſome particulars relative to earthquakes not to be found elſewhere. From the whole of theſe accounts we may gather, that the moſt concomitant circumſtances are theſe:

A rumbling ſound before the earthquake. This proceeds from the air, or fire or both, forcing their way through the chaſms of the earth, and endeavouring to get free, which is alſo heard in volcanoes.

A violent agitation or heaving of the ſea, ſometimes before and ſometimes after that at land. This agitation is only a ſimilar effect produced on the waters with that at land, and may be called, for the ſake of perſpicuity, a *ſeaquake;* and this, alſo, is produced by volcanoes.

A ſpouting up of waters to great heights. It is not eaſy to deſcribe the manner in which this is performed; but volcanoes alſo perform the ſame. Veſuvius being known frequently to eject a vaſt body of water.

A rocking of the earth to and fro, and ſometimes a perpendicular bouncing, if it may be ſo called, of the ſame. This difference chiefly ariſes from the ſituation of the place with reſpect to the ſubterranean fire. Directly under, it lifts; at a farther diſtance, it rocks.

Some earthquakes ſeem to travel onward, and are felt in different countries at different hours the ſame day. This ariſes from the great ſhock being given to the earth at one place, and that being communicated onward by an undulatory motion, ſucceſſively affects different regions in its progreſs. As the blow given by a ſtone falling in a lake, is not perceived at the ſhores till ſome time after the firſt concuſſion.

The ſhock is ſometimes inſtantaneous, like the exploſion of gunpowder; and ſometimes tremulous, and continuing for ſeveral minutes. The nearer the place where the ſhock is firſt given, the more inſtantaneous and ſimple it appears. At a greater diſtance, the earth redoubles the firſt blow with a ſort of vibratory continuation.

As waters have generally ſo great a ſhare in producing earthquakes, it is not to be wondered that they ſhould generally follow thoſe breaches made by the force of fire, and appear in the great chaſms which the earthquake has opened.

Theſe are ſome of the moſt remarkable phænomena of earthquakes, preſenting a frightful aſſemblage of the moſt terrible effects of air, earth, fire, and water.

The valley of Solfatara, near Naples, ſeems to exhibit, in a minuter degree, whatever is ſeen of this horrible kind on the great theatre of Nature. This plain, which is about twelve hundred feet long, and a thouſand broad, is emboſomed in mountains, and has in the middle of it a lake of noiſome blackiſh water, covered with a bitumen, that floats upon its ſurface. In every part of this plain, caverns appear ſmoking with ſulphur, and often emitting flames. The earth, wherever we walk over it, trembles beneath the feet. Noiſes of flames, and the hiſſing of waters, are heard at the bottom. The water ſometimes ſpouts up eight or ten feet high. The moſt noiſome fumes, fœtid water, and ſulphureous vapours, offend the ſmell. A ſtone thrown into any of the caverns is ejected again, with conſiderable violence. Theſe appearances generally prevail when the ſea is any way diſturbed; and the whole ſeems to exhibit the appearance of an earthquake in miniature. However, in this ſmaller ſcene of wonders, as well as in the greater, there are many appearances for which, perhaps, we ſhall never account; and many queſtions may be aſked, which no conjectures can thoroughly reſolve. It was the fault of the philoſophers of the laſt age, to be more inquiſitive after the cauſes of things, than after the things themſelves. They ſeemed to think that a confeſſion of ignorance cancelled their claims to wiſdom: they, therefore, had a ſolution for every demand. But the preſent age has grown, if not more inquiſitive, at leaſt more modeſt; and none are now aſhamed of that ignorance, which labour can neither remedy nor remove.

CHAP. XI.

OF THE APPEARANCE OF NEW ISLANDS AND TRACTS; AND OF THE DISAPPEARING OF OTHERS.

HITHERTO we have taken a ſurvey only of the evils which are produced by ſubterranean fires, but we have mentioned nothing of the benefits they may poſſibly produce. They may be of uſe in warming and cheriſhing the ground, in promoting vegetation, and giving a more exquiſite flavour to the productions of the earth. The imagination of a perſon who has never been out of our own mild region, can ſcarcely reach to that luxuriant beauty with which all Nature appears clothed in thoſe very countries that we have juſt now deſcribed as deſolated by earthquakes, and undermined by ſubterranean fires. It muſt be granted, therefore, that though in thoſe regions they have a greater ſhare in the dangers, they have alſo a larger proportion in the benefits of Nature.

But there is another advantage ariſing from ſubterranean fires, which, though hitherto diſregarded by man, yet may one day become ſerviceable to him; I mean, that while they are found to ſwallow up cities and plains in one place, they are alſo known to produce promontories and iſlands in another. We have many inſtances of iſlands being thus formed in the midſt of the ſea, which though for a long time barren, have afterwards become fruitful ſeats of happineſs and induſtry.

New iſlands are formed in two ways; either ſuddenly, by the action of ſubterraneous fires; or more ſlowly, by the depoſition of mud, carried down by rivers, and ſtopped by ſome accident*. With reſpect particularly to the firſt, ancient hiſtorians, and modern travellers, give us ſuch accounts as we can have no room to doubt of. Seneca aſſures us, that in his time the iſland of Theraſia appeared unexpectedly to ſome mariners, as they were employed in another purſuit.—Pliny aſſures us, that thirteen iſlands in the Mediterranean appeared at once emerging from the water; the cauſe of which he aſcribes rather to the retiring of the ſea in thoſe parts, than to any ſubterraneous elevation. However, he mentions the iſland of Hiera, near that of Theraſia, as formed by ſubterraneous exploſions; and adds to his liſt ſeveral others, formed in the ſame manner. In one of which he relates that fiſh in great abundance were found, and that all thoſe who eat of them died ſhortly after.

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* Buffon, vol. ii. p. 343.

"On the twenty-fourth of May*, in the year 1707, a ſlight earthquake was perceived at Santorin; and the day following, at ſun-riſing, an object was ſeen by the inhabitants of that iſland, at two or three miles diſtance at ſea, which appeared like a floating rock. Some perſons, deſirous either of gain, or incited by curioſity, went there, and found, even while they ſtood upon this rock, that it ſeemed to riſe beneath their feet. They perceived alſo, that its ſurface was covered with pumice-ſtones and oyſters, which it had raiſed from the bottom. Every day after, until the fourteenth of June, this rock ſeemed conſiderably to increaſe; and then was found to be half a mile round, and about thirty feet above the ſea. The earth of which it was compoſed ſeemed whitiſh, with a ſmall proportion of clay. Soon after this the ſea again appeared troubled, and ſteams aroſe which were very offenſive to the inhabitants of Santorin. But on the ſixteenth of the ſucceeding month, ſeventeen or eighteen rocks more were ſeen to riſe out of the ſea, and at length to join together. All this was accompanied with the moſt terrible noiſe, and fires that proceeded from the iſland that was newly formed. The whole maſs, however, of all this new-formed earth, uniting, increaſed every day, both in height and breadth, and, by the force of its exploſions, caſt forth rocks to ſeven miles diſtance. This continued to bear the ſame dreadful appearances till the month of November in the ſame year; and it is at preſent a volcano which ſometimes renews its exploſions. It is about three miles in circumference; and more than from thirty-five to forty feet high."

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* Hiſt. del Acad. an. 1708, p. 23.

It ſeems extraordinary, that about this place in particular, iſlands have appeared at different times, particularly that of Hiera, mentioned above, which has received conſiderable additions in ſucceeding ages. Juſtin tells us*, that at the time the Macedonians were at war with the Romans, a new iſland appeared between thoſe of Theramenes and Theraſia, by means of an earthquake. We are told, that this became half as large again, about a thouſand years after, another iſland riſing up by its ſide, and joining to it, ſo as ſcarce at preſent to be diſtinguiſhed from the former.

A new iſland was formed, in the year 1720, near that of Tercera, near the continent of Africa, by the ſame cauſes. In the beginning of December, at night, there was a terrible earthquake at that place, and the top of a new iſland appeared, which caſt forth ſmoke in vaſt quantities. The pilot of a ſhip, who approached it, ſounded on one ſide of this iſland, and could not find ground at ſixty fathom: At the other ſide the ſea was totally tinged of a different colour, exhibiting a mixture of white, blue, and green; and was very ſhallow.— This iſland, on its firſt appearance, was larger than it is at preſent; for it has ſince that time, ſunk in ſuch a manner, as to be ſcarce above water.

A traveller, whom theſe appearances could not avoid affecting, ſpeaks of them in this manner: †" What can be more ſurpriſing than to ſee fire not only break out of the bowels of the earth, but alſo make itſelf a paſſage through the waters of the ſea! What can be more extraordinary or foreign to our common notions of things, than to ſee the bottom of the ſea riſe up into a mountain above the water, and become ſo firm an iſland as to be able to reſiſt the violence of the greateſt ſtorms! I know that ſubterraneous fires, when pent in a narrow paſſage, are able to raiſe up a maſs of earth as large as an iſland. But that this ſhould be done in ſo regular and exact a manner that the water of the ſea ſhould not be able to penetrate and extinguiſh thoſe fires; that after having made ſo many paſſages, they ſhould retain force enough to raiſe the earth; and, in fine, after having been extinguiſhed, that the maſs of earth ſhould not fall down, or ſink again with its own weight, but ſtill remain in a manner ſuſpended over the great arch below! This is what to me ſeems more ſurpriſing than any thing that has been related of Mount Ætna, Veſuvius, or any other volcano."

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* Juſtin, lib. xxx. cap. 4.

† Phil. Tranſ. vol.v. p. 197.

Such are his ſentiments; however, there are few of theſe appearances any way more extraordinary than thoſe attending volcanoes and earthquakes in general. We are not more to be ſurpriſed that inflammable ſubſtances ſhould be found beneath the bottom of the ſea, than at ſimilar depths at land. Theſe have all the force of fire giving expanſion to air, and tending to raiſe the earth at the bottom of the ſea, till it at length heaves above water. Theſe marine volcanoes are not ſo frequent; for, if we may judge of the uſual procedure of Nature, it muſt very often happen that, before the bottom of the ſea is elevated above the ſurface, a chaſm is opened in it, and then the water preſſing in, extinguiſhes the volcano before it has time to produce its effects. This extinction, however, is not effected without very great reſiſtance from the fire beneath. The water, upon daſhing into the cavern, is very probably at firſt ejected back with great violence; and thus ſome of thoſe amazing water-ſpouts are ſeen, which have ſo often aſtoniſhed the mariner, and excited curioſity.—But of theſe in their place.

Beſides the production of thoſe iſlands by the action of fire, there are others, as was ſaid, produced by rivers or ſeas carrying mud, earth, and ſuch like ſubſtances, along with their currents; and at laſt depoſiting them in ſome particular place. At the mouths of moſt great rivers, there are to be ſeen banks, thus formed by the ſand and mud carried down with the ſtream, which have reſted at that place, where the force of the current is diminiſhed by its junction with the ſea. Theſe banks, by ſlow degrees, increaſe at the bottom of the deep; the water in thoſe places, is at firſt found by mariners to grow more ſhallow; the bank ſoon heaves up above the ſurface; it is conſidered, for a while, as a tract of uſeleſs and barren ſand; but the ſeeds of ſome of the more hardy vegetables are driven thither by the wind, take root, and thus binding the ſandy ſurface, the whole ſpot is clothed in time with a beautiful verdure. In this manner there are delightful and inhabited iſlands at the mouths of many rivers, particularly the Nile, the Po, the Miſſiſſippi, the Ganges, and the Senegal. There has been, in the memory of man, a beautiful and large iſland formed in this manner, at the mouth of the river Nanquin, in China, made from depoſitions of mud at its opening: it is not leſs than ſixty miles long, and about twenty broad. La Loubere informs us*, in his voyage to Siam, that theſe ſand-banks increaſe every day, at the mouths of all the great rivers in Aſia: and hence, he aſſerts, that the navigation up theſe rivers becomes every day more difficult; and will, at one time or other, be totally obſtructed. The ſame may be remarked with regard to the Wolga, which has at preſent ſeventy openings into the Caſpian ſea; and of the Danube, which has ſeven into the Euxine. We have had an inſtance of the formation of a new iſland not very long ſince at the mouth of the Humber, in England. "It is yet within the memory of man," ſays the relator*, "ſince it began to raiſe its head above the ocean. It began its appearance at low water, for the ſpace of a few hours; and was buried again till the next tide's retreat. Thus, ſucceſſively, it lived and died, until the year 1666, when it began to maintain its ground againſt the inſult of the waves; and firſt invited the aid of human induſtry. A bank was thrown about its riſing grounds; and, being thus defended from the incurſions of the ſea, it became firm and ſolid, and, in a ſhort time, afforded good paſturage for cattle. It is about nine miles in circumference, and is worth to the proprietor about eight hundred pounds a-year." It would be endleſs to mention all the iſlands that have been thus formed, and the advantages that have been derived from them. However, it is frequently found, that new iſlands may be often conſidered as only turning the rivers from their former beds; ſo that in proportion as land is gained at one part, it is loſt by the overflowing of ſome other.

Little, therefore, is gained by ſuch acceſſions; nor is there much more by the new iſlands which are ſometimes formed from the ſpoils of the continent. Mariners aſſure us, that there are ſometimes whole plains unrooted from the main lands, by floods and tempeſts. Theſe being carried out to ſea, with all the trees and animals upon them, are frequently ſeen floating in the ocean, and exhibiting a ſurpriſing appearance of rural tranquillity in the midſt of danger. The greateſt part, however, having the earth at their roots at length waſhed away, are diſperſed, and their animals drowned; but now and then ſome are found to brave the fury of the ocean, till being ſtuck either among rocks or ſands, they again take firm footing, and become permanent iſlands.

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* Lettres Curieuſes et Edifiantes, ſec. xi. p. 234.

† Phil. Tranſ. vol. iv. p. 251.

As different cauſes have thus concurred to produce new iſlands, ſo we have accounts of others that the ſame cauſes have contributed to deſtroy. We have already ſeen the power of earthquakes exerted in ſinking whole cities, and leaving lakes in their room. There have been iſlands, and regions alſo, that have ſhared the ſame fate; and have ſunk with their inhabitants never more to be heard of. Thus Pauſanias * tells us of an iſland, called Chryſes, that was ſunk near Lemnos. Pliny mentions ſeveral; among others, the iſland Cea, for thirty miles, having been waſhed away, with ſeveral thouſands of its inhabitants. But of all the noted devaſtations of this kind, the total ſubmerſion of the iſland of Atalantis, as mentioned by Plato, has been moſt the ſubject of ſpeculation. Mankind, in general, now conſider the whole of his deſcription as an ingenious fable; but when fables are grown famous by time and authority, they become an agreeable, if not a neceſſary part of literary information.

"About nine thouſand years are paſſed," ſays Plato †, "ſince the iſland of Atalantis was in being. The prieſts of Egypt were well acquainted with it; and the firſt heroes of Athens gained much glory in their wars with the inhabitants. This iſland was as large as Aſia Minor and Syria united; and was ſituated beyond the Pillars of Hercules, in the Atlantic ocean. The beauty of the buildings and the fertility of the ſoil, were far beyond any thing a modern imagination can conceive; gold and ivory were every where common;

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* Pauſanias, l. 8. in Arcad. p. 509.

† Plato in Critia.

and the fruits of the earth offered themſelves without cultivation. The arts and courage of the inhabitants, were not inferior to the happineſs of their ſituation; and they were frequently known to make conqueſts, and overrun the continents of Europe and Aſia." The imagination of the poetical philoſopher riots in the deſcription of the natural and acquired advantages, which they long enjoyed in this charming region. "If," ſays he, "we compare that country to our own, ours will appear a mere waſted ſkeleton, when oppoſed to it. The mountains to the very tops were clothed with fertility, and poured down rivers to enrich the plains below."

However, all theſe beauties and benefits were deſtroyed in one day by an earthquake ſinking the earth, and the ſea overwhelming it. At preſent, not the ſmalleſt veſtiges of ſuch an iſland are to be found; Plato remains as the only authority for its exiſtence; and philoſophers diſpute about its ſituation. It is not for me to enter into the controverſy, when there appears but little probability to ſupport the fact; and, indeed, it would be uſeleſs to run back nine thouſand years in ſearch of difficulties, as we are ſurrounded with objects that more cloſely affect us, and that demand admiration at our very doors. When I conſider, as Lactantius ſuggeſts, the various viciſſitudes of Nature; lands ſwallowed by yawning earthquakes, or overwhelmed in the deep; rivers and lakes diſappearing, or dried away; mountains levelled into plains; and plains ſwelling up into mountains; I cannot help regarding this earth as a place of very little ſtability: as a tranſient abode of ſtill more tranſitory beings.

CHAP. XII.

OF MOUNTAINS.

HAVING at laſt, in ſome meaſure, emerged from the deeps of the earth, we come to a ſcene of greater ſplendour; the contemplation of its external appearance. In this ſurvey, its mountains are the firſt objects that ſtrike the imagination, and excite our curioſity. There is not, perhaps, any thing in all Nature that impreſſes an unaccuſtomed ſpectator with ſuch ideas of awful ſolemnity, as theſe immenſe piles of Nature's erecting, that ſeem to mock the minuteneſs of human magnificence.

In countries where there are nothing but plains, the ſmalleſt elevations are apt to excite wonder. In Holland, which is all a flat, they ſhew a little ridge of hills, near the ſea-ſide, which Boerhaave generally marked out to his pupils, as being mountains of no ſmall conſideration. What would be the ſenſations of ſuch an auditory, could they at once be preſented with a view of the heights and precipices of the Alps or the Andes! Even among us in England, we have no adequate ideas of a mountain-proſpect; our hills are generally ſloping from the plain, and clothed to the very top with verdure; we can ſcarce, therefore, lift our imaginations to thoſe immenſe piles, whoſe tops peep up behind intervening clouds, ſharp and precipitate, and reach to heights that human avarice or curioſity have never been able to aſcend.

We, in this part of the world, are not, for that reaſon, ſo immediately intereſted in the queſtion which has ſo long been agitated among philoſophers, concerning what gave riſe to theſe inequalities on the ſurface of the globe. In our own happy region, we generally ſee no inequalities but ſuch as contribute to uſe and beauty; and we, therefore, are amazed at a queſtion inquiring how ſuch neceſſary inequalities came to be formed, and ſeeming to expreſs a wonder how the globe comes to be ſo beautiful as we find it. But though with us there may be no great cauſe for ſuch a demand, yet in thoſe places where mountains deform the face of Nature, where they pour down cataracts, or give fury to tempeſts, there ſeems to be good reaſon for inquiry either into their cauſes or their uſes. It has been, therefore, aſked by many, in what manner mountains have come to be formed; or for what uſes they are deſigned?

To ſatisfy curioſity in theſe reſpects, much reaſoning has been employed, and very little knowledge propagated. With regard to the firſt part of the demand, the manner in which mountains were formed, we have already ſeen the conjectures of different philoſophers on that head. One ſuppoſing that they were formed from the earth's broken ſhell at the time of the deluge: another, that they exiſted from the creation, and only acquired their deformities in proceſs of time; a third, that they owed their original to earthquakes: and ſtill a fourth, with much more plauſibility than the reſt, aſcribing them entirely to the fluctuations of the deep, which he ſuppoſes in the beginning to have covered the whole earth. Such as are pleaſed with diſquiſitions of this kind, may conſult Burnet, Whiſton, Woodward, or Buffon. Nor would I be thought to decry any mental amuſements, that at worſt keep us innocently employed; but, for my own part, I cannot help wondering how the oppoſite demand has never come to be made; and why philoſophers have never aſked how we come to have plains? Plains are ſometimes more prejudicial to man than mountains. Upon plains, an inundation has greater power; the beams of the ſun are often collected there with ſuffocating fierceneſs; they are ſometimes found deſert for ſeveral hundred miles together, as in the country eaſt of the Caſpian ſea, although otherwiſe fruitful, merely becauſe there are no riſings nor depreſſions to form reſervoirs, or collect the ſmalleſt rivulet of water. The moſt rational anſwer, therefore, why, either mountains or plains were formed, ſeems to be that they were thus faſhioned by the hand of Wiſdom, in order that pain and pleaſure ſhould be ſo contiguous, as that mortality might be exerciſed either in bearing the one, or communicating the other.

Indeed, the more I conſider this diſpute reſpecting the formation of mountains, the more I am ſtruck with the futility of the queſtion. There is neither a ſtraight line, nor an exact ſuperficies, in all Nature. If we conſider a circle, even with mathematical preciſion, we ſhall find it formed of a number of ſmall right lines, joining at angles together. Theſe angles, therefore, may be conſidered in a circle as mountains are upon our globe; and to demand the reaſon for the one being mountainous, or the other angular, is only to aſk, why a circle is a circle, or a globe is a globe. In ſhort, if there be no ſurface without inequality in Nature, why ſhould we be ſurpriſed that the earth has ſuch? It has often been ſaid, that the inequalities of its ſurface are ſcarce diſtinguiſhable, if compared to its magnitude; and I think we have every reaſon to be content with the anſwer.

Some, however, have avoided the difficulty by urging the final cauſe. They allege that mountains have been formed merely becauſe they are uſeful to man. This carries the inquirer but a part of the way; for no one can affirm, that in all places they are uſeful. The contrary is known, by horrid experience, in thoſe valleys that are ſubject to their influence. However, as the utility of any part of our earthly habitation is a very pleaſing and flattering ſpeculation to every philoſopher, it is not to be wondered that much has been ſaid to prove the uſefulneſs of theſe. For this purpoſe, many conjectures have been made that have received a degree of aſſent even beyond their evidence; for men were unwilling to become more miſerably wiſe.

It has been alleged, as one principal advantage that we derive from them, that they ſerve, like hoops or ribs, to ſtrengthen our earth, and to bind it together. In conſequence of this theory, Kircher has given us a map of the earth, in this manner hooped with its mountains; which might have a much more ſolid foundation, did it entirely correſpond with truth.

Others have found a different uſe for them, eſpecially when they run ſurrounding our globe; which is, that they ſtop the vapours which are continually travelling from the equator to the poles; for theſe being urged by the heat of the ſun, from the warm regions of the line, muſt all be accumulated at the poles, if they were not ſtopped in their way by thoſe high ridges of mountains which croſs their direction. But an anſwer to this may be, that all the great mountains in America lie lengthwiſe, and therefore do not croſs their direction.

But to leave theſe remote advantages, others aſſert, that not only the animal but vegetable part of the creation would periſh for want of convenient humidity, were it not for their friendly aſſiſtance. Their ſummits are, by theſe, ſuppoſed to arreſt, as it were, the vapours which float in the regions of the air. Their large inflexions and channels are conſidered as ſo many baſons prepared for the reception of thoſe thick vapours, and impetuous rains, which deſcend into them. The huge caverns beneath are ſo many magazines or conſervatories of water for the peculiar ſervice of man: and thoſe orifices by which the water is diſcharged upon the plain, are ſo ſituated as to enrich and render them fruitful, inſtead of returning through ſubterraneous channels to the ſea, after the performance of a tedious and fruitleſs circulation *.

However this be, certain it is that almoſt all our great rivers find their ſource among mountains; and, in general, the more extenſive the mountain, the greater the river: thus the river Amazons, the greateſt in the world, has its ſource among the Andes, which are the higheſt mountains on the globe; the river Niger travels a long courſe of ſeveral hundred miles from the Mountains of the Moon, the higheſt in all Africa; and the Danube and the Rhine proceed from the Alps, which are probably the higheſt mountains of Europe.

It need ſcarce be ſaid that, with reſpect to height, there are many ſizes of mountains, from the gently riſing upland, to the tall craggy precipice. The appearance is in general different in thoſe of different magnitudes. The firſt are clothed with verdure to the very tops, and only ſeem to aſcend to improve our proſpects, or ſupply us with a purer air: but the lofty mountains of the other claſs have a very different aſpect. At a diſtance their tops are ſeen, in wavy ridges, of the very colour of the clouds, and only to be diſtinguiſhed from them by their figure; which, as I have ſaid, reſemble the billows of the ſea †. As we approach, the mountain aſſumes a deeper colour; it gathers upon the ſky, and ſeems to hide half the horizon behind it. Its ſummits alſo are become more diſtinct, and appear with a broken and perpendicular line. What at firſt ſeemed a ſingle hill, is now found to be a chain of continued mountains, whoſe tops running along in ridges, are emboſomed in each other; ſo that the curvatures of one are fitted to the prominences of the oppoſite ſide, and form a winding valley between, often of ſeveral miles in extent; and all the way continuing nearly of the ſame breadth.

Nothing can be finer, or more exact, than Mr. Pope's deſcription of a traveller ſtraining up the Alps. Every mountain he comes to, he thinks will be the laſt; he finds, how-

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* Nature Diſplayed, vol. iii. p. 88.

† Lettres Philoſophiques ſur la Formation, &c. p. 196.

ever, an unexpected hill riſe before him; and that being ſcaled, he finds the higheſt ſummit almoſt at as great a diſtance as before. Upon quitting the plain, he might have left a green and a fertile ſoil, and a climate warm and pleaſing. As he aſcends, the ground aſſumes a more ruſſet colour; the graſs becomes more moſſy, and the weather more moderate. Still as he aſcends, the weather becomes more cold, and the earth more barren. In this dreary paſſage, he is often entertained with a little valley of ſurpriſing verdure, cauſed by the reflected heat of the ſun collected into a narrow ſpot on the ſurrounding heights. But it much more frequently happens that he ſees only frightful precipices beneath, and lakes of amazing depths from whence rivers are formed, and fountains derive their original. On thoſe places next the higheſt ſummits, vegetation is ſcarcely carried on; here and there a few plants of the moſt hardy kind appear. The air is intolerably cold; either continually refrigerated with froſts, or diſturbed with tempeſts. All the ground here wears an eternal covering of ice, and ſnows that ſeem conſtantly accumulating. Upon emerging from this war of the elements, he aſcends into a purer and ſerener region, where vegetation is entirely ceaſed; where the precipices, compoſed entirely of rocks, riſe perpendicularly above him; while he views beneath him all the combat of the elements; clouds at his feet, and thunders darting upward from their boſoms below*. A thouſand meteors, which are never ſeen on the plain preſent themſelves. Circular rainbows†; mock ſuns; the ſhadow of the mountain projected upon the body of the air‡; and the traveller's own image, reflected as in a looking-glaſs, upon the oppoſite cloud‖.

Such are, in general, the wonders that preſent themſelves to a traveller in his journey either over the Alps or the Andes. But we muſt not ſuppoſe that this picture exhibits either a conſtant or an invariable likeneſs of thoſe ſtupendous heights. Indeed, nothing can be more capricious or irregular than the forms of many of them. The tops of ſome run in ridges for a conſiderable length, without interruption; in others, the line ſeems indented by great valleys to an amazing depth. Sometimes a ſolitary and a ſingle mountain riſes from the boſom of the plain; and ſometimes extenſive plains, and even provinces, as thoſe of Savoy and Quito, are found emboſomed near the tops of mountains. In general, however, thoſe countries that are moſt mountainous, are the moſt barren and uninhabitable.

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* Ulloa, vol. i. † Ibid. ‡ Phil. Tranſ. vol. v. p. 152.

§ Ulloa, vol. i.

If we compare the heights of mountains with each other, we ſhall find that the greateſt and higheſt are found under the line*. It is thought by ſome, that the rapidity of the earth's motion in theſe parts, together with the greatneſs of the tides there, may have thrown up thoſe ſtupendous maſſes of earth. But, be the cauſe as it may, it is a remarkable fact, that the inequalities of the earth's ſurface are greateſt there. Near the poles, the earth, indeed, is craggy and uneven enough; but the heights of the mountains there, are very inconſiderable. On the contrary, at the equator, where Nature ſeems to ſport in the amazing ſize of all her productions, the plains are extenſive, and the mountains remarkably lofty. Some of them are known to riſe three miles perpendicular above the bed of the ocean.

To enumerate the moſt remarkable of theſe, according to their ſize, we ſhall begin with the Andes, of which we have an excellent deſcription by Ulloa, who went thither by command of the King of Spain, in company with the French Academicians, to meaſure a degree of the meridian. His journey up theſe mountains is too curious not to give an extract from it.

After many incommodious days ſailing up the river Guayquil, he arrived at Caracol, a town ſituated at the foot of the Andes. Nothing could exceed the inconveniences which he experienced in this voyage, from the flies and moſchitoes (an animal reſembling our gnat). "We were the whole day," ſays he, "in continual motion to keep them off; but at night our torments were exceſſive. Our gloves, indeed, were ſome defence to our hands; but our faces were entirely expoſed; nor were our clothes a ſufficient defence for the reſt of our bodies; for their ſtings penetrating through the cloth, cauſed a very painful and fiery itching. One night, in coming to an anchor near a large and handſome houſe that was uninhabited, we had no ſooner ſeated ourſelves in it, than we were attacked on all ſides by ſwarms of moſchitoes, ſo that it was impoſſible to have one moment's quiet. Thoſe who had covered themſelves with clothes made for this purpoſe, found not the ſmalleſt defence; wherefore, hoping to find ſome relief in the open fields, they ventured out, though in danger of ſuffering in a more terrible manner from the ſerpents. But both places were equally obnoxious. On quitting this inhoſpitable retreat, we the next night took up our quarters in an houſe that was inhabited; the hoſt of which being informed of the terrible manner we had paſt the night before, he gravely told us, that the houſe we ſo greatly complained of, had been forſaken on account of its being the purgatory of a ſoul. But we had more reaſon to believe that it was quitted on account of its being the purgatory of the body. After having journeyed for upwards of three days, through boggy roads, in which the mules at every ſtep ſunk up to their bellies, we began at length to perceive an alteration in the climate; and having been long accuſtomed to heat, we now began to feel it grown ſenſibly colder.

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* Buffon, paſſim.

"It is remarkable, that at Tariguagua we often ſee inſtances of the effects of two oppoſite temperatures, in two perſons happening to meet; one of them leaving the plains below, and the other deſcending from the mountain. The former thinks the cold ſo ſevere, that he wraps himſelf up in all the garments he can procure; while the latter, finds the heat ſo great, that he is ſcarce able to bear any clothes whatſoever. The one thinks the water ſo cold, that he avoids being ſprinkled by it; the other is ſo delighted with its warmth, that he uſes it as a bath. Nor is the caſe very different in the ſame perſon, who experiences the ſame diverſity of ſenſation upon his journey up, and upon his return. This difference only proceeds from the change naturally felt at leaving a climate to which one has been accuſtomed, and coming into another of an oppoſite temperature.

"The ruggedneſs of the road from Tariguagua, leading up the mountain, is not eaſily deſcribed. In ſome parts, the declivity is ſo great, that the mules can ſcarce keep their footing; and in others, the acclivity is equally difficult.

The trouble of having people going before to mend the road the pains ariſing from the many falls and bruiſes, and the being conſtantly wet to the ſkin, might be ſupported, were not theſe inconveniences augmented by the ſight of ſuch frightful precipices, and deep abyſſes, as muſt fill the mind with ceaſeleſs terror. There are ſome places where the road is ſo ſteep, and yet ſo narrow, that the mules are obliged to ſlide down, without making any uſe of their feet whatſoever. On one ſide of the rider, in this ſituation, riſes an eminence of ſeveral hundred yards; and on the other, an abyſs of equal depth; ſo that if he in the leaſt checks his mule, ſo as to deſtroy the equilibrium, they both muſt unavoidably periſh.

" After having travelled about nine days in this manner, ſlowly winding along the ſide of the mountain, we began to find the whole country covered with an hoar froſt; and an hut in which we lay, had ice on it. Having eſcaped many perils, we at length, after a journey of fifteen days, arrived upon the plain, on the extremity of which ſtands the city of Quito, the capital of one of the moſt charming regions upon earth. Here, in the centre of the torrid zone, the heat is not only very tolerable, but in ſome places the cold alſo is painful. Here they enjoy all the temperature and advantages of perpetual ſpring; their fields being always covered with verdure, and enamelled with flowers of the moſt lively colours. However, although this beautiful region be higher than any other country in the world, and although it took up ſo many days of painful journey in the aſcent, it is ſtill overlooked by tremendous mountains; their ſides covered with ſnow, and yet flaming with volcanoes at the top. Theſe ſeemed piled one upon the other, and riſe to a moſt aſtoniſhing height, with great coldneſs. However, at a determined point above the ſurface of the ſea, the congelation is found at the ſame height in all the mountains. Thoſe parts which are not ſubject to a continual froſt, have here and there growing upon them a ruſh, reſembling the geniſta, but much more ſoft and flexible. Towards the extremity of the part where the ruſh grows, and the cold begins to increaſe, is found a vegetable, with a round bulbous head, which, when dried, becomes of amazing elaſticity. Higher up, the earth is entirely bare of vegetation, and ſeems covered with eternal ſnow. The moſt remarkable mountains are, that of Cotopaxi, (already deſcribed as a volcano) Chimborazo, and Pichincha. Cotopaxi is more than three geographical miles above the ſurface of the ſea: the reſt are not much inferior. On the top of the latter was my ſtation for meaſuring a degree of the meridian; where I ſuffered particular hardſhips, from the intenſeneſs of the cold, and the violence of the ſtorms. The ſky around was, in general, involved in thick fogs, which, when they cleared away, and the clouds, by their gravity, moved nearer to the ſurface of the earth, they appeared ſurrounding the foot of the mountain, at a vaſt diſtance below, like a ſea, encompaſſing an iſland in the midſt of it. When this happened, the horrid noiſes of tempeſts were heard from beneath, then diſcharging themſelves on Quito, and the neighbouring country. I ſaw the lightnings iſſue from the clouds, and heard the thunders roll far beneath me. All this time, while the tempeſt was raging below, the mountain top, where I was placed, enjoyed a delightful ſerenity; the wind was abated; the ſky clear; and the enlivening rays of the ſun moderated the ſeverity of the cold. However, this was of no very long duration, for the wind returned with all its violence, and with ſuch velocity as to dazzle the ſight; whilſt my fears were increaſed by the dreadful concuſſions of the precipice, and the fall of enormous rocks; the only ſounds that were heard in this frightful ſituation."

Such is the animated picture of theſe mountains, as given us by this ingenious Spaniard: and I believe the reader will wiſh that I had made the quotation ſtill longer. A paſſage over the Alps, or a journey acroſs the Pyrenees, appear petty trips or excurſions in the compariſon; and yet theſe are the moſt lofty mountains we know of in Europe.

If we compare the Alps with the mountains already deſcribed, we ſhall find them but little more than one half of the height of the former. The Andes, upon being meaſured by the barometer, are found above three thouſand, one hundred and thirty-ſix toiſes or fathoms above the ſurface of the ſea*. Whereas the higheſt points of the Alps is not above ſixteen hundred. The one, in other words, is above three miles high; the other about a mile and a half. The higheſt mountains in Aſia are, Mount Taurus, Mount Immaus, Mount Caucaſus, and the mountains of Japan.—Of theſe, none equals the Andes in height; although Mount Caucaſus, which is the higheſt of them, makes very near approaches. Father Verbieſt tells of a mountain in China, which he meaſured, and found a mile and a half high *. In Africa, the mountains of the Moon, famous for giving ſource to the Niger, and the Nile, are rather more noted than known. Of the Peak of Teneriffe, one of the Canary Iſlands that lie off this coaſt, we have more certain information. In the year 1727, it was viſited by a company of Engliſh merchants, who travelled up to the top, where they obſerved its height, and the volcano on its very ſummit †. They found it a heap of mountains; the higheſt of which riſes over the reſt like a ſugar-loaf, and gives a name to the whole maſs. It is computed to be a mile and a half perpendicular from the ſurface of the ſea. Kircher gives us an eſtimate of the heights of moſt of the other great mountains in the world; but as he has taken his calculations in general from the ancients, or from modern travellers, who had not the art of meaſuring them, they are quite incredible. The art of taking the heights of places by the barometer, is a new, and an ingenious invention. As the air grows lighter as we aſcend, the fluid in the tube riſes in due proportion: Thus the inſtrument being properly marked, gives the height with a tolerable degree of exactneſs; at leaſt enough to ſatisfy curioſity.

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* Ulloa, vol. i. p. 442.

Few of our great mountains have been eſtimated in this manner; travellers having, perhaps, been deterred, by a ſuppoſed impoſſibility of breathing at the top. However, it has been invariably found, that the air in the higheſt that our modern travellers have aſcended, is not at all too fine for reſpiration. At the top of the Peak of Teneriffe, there was found no other inconvenience from the air, except its coldneſs; at the top of the Andes, there was no difficulty of breathing perceived. The accounts, therefore, of thoſe who have aſſerted that they were unable to breathe, although at

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* Verbieſt, alla Chine.

† Phil. Tranſ. vol. v.

much leſs heights, are greatly to be ſuſpected. In fact, it is very natural for mankind to paint thoſe obſtacles as inſurmountable, which they themſelves have not had the fortitude or perſeverance to ſurmount.

The difficulty and danger of aſcending to the tops of mountains, proceeds from other cauſes, not the thinneſs of the air. For inſtance, ſome of the ſummits of the Alps have never yet been viſited by man. But the reaſon is, that they riſe with ſuch a rugged and precipitate aſcent, that they are utterly inacceſſible. In ſome places they appear like a great wall of ſix or ſeven hundred feet high; in others, there ſtick out enormous rocks, that hang upon the brow of the ſteep, and every moment threaten deſtruction to the traveller below.

In this manner almoſt all the tops of the higheſt mountains are bare and pointed. And this naturally proceeds from their being ſo continually aſſaulted by thunders and tempeſts. All the earthy ſubſtances with which they might have been once covered, have for ages been waſhed away from their ſummits; and nothing is left remaining but immenſe rocks, which no tempeſt has hitherto been able to deſtroy.

Nevertheleſs, time is every day, and every hour, making depredations; and huge fragments are ſeen tumbling down the precipice, either looſened from the ſummit by froſt or rains, or ſtruck down by lightning. Nothing can exhibit a more terrible picture than one of theſe enormous rocks, commonly larger than an houſe, falling from its height, with a noiſe louder than thunder, and rolling down the ſide of the mountain. Doctor Plot tells us of one in particular, which being looſened from its bed, tumbled down the precipice, and was partly ſhattered into a thouſand pieces. Notwithſtanding, one of the largeſt fragments of the ſame, ſtill preſerving its motion, travelled over the plain below, croſſed a rivulet in the midſt, and at laſt ſtopped on the other ſide of the bank! Theſe fragments, as was ſaid, are often ſtruck off by lightning, and ſometimes undermined by rains; but the moſt uſual manner in which they are diſunited from the mountain, is by froſt: the rains inſinuating between the interſtices of the mountain, continue there until there comes a froſt, and then, when converted into ice, the water ſwells with an irreſiſtible force, and produces the ſame effect as gunpowder, ſplitting the moſt ſolid rocks, and thus ſhattering the ſummits of the mountain.

But not rocks alone, but whole mountains are, by various cauſes, diſunited from each other. We ſee, in many parts of the Alps, amazing clefts, the ſides of which ſo exactly correſpond with the oppoſite, that no doubt can be made of there having been once joined together. At Cajeta*, in Italy, a mountain was ſplit in this manner by the earthquake; and there is a paſſage opened through it, that appears as if elaborately done by the induſtry of man. In the Andes theſe breaches are frequently ſeen. That at Thermopyle, in Greece, has been long famous. The mountain of the Troglodytes, in Arabia, has thus a paſſage through it: and that in Savoy, which Nature began, and which Victor Amadeus completed, is an inſtance of the ſame kind.

We have accounts of ſome of theſe diſruptions, immediately after their happening. "In the month of June†, in the year 1714, a part of the mountain of Diableret, in the diſtrict of Valais, in France, ſuddenly fell down, between two and three o'clock in the afternoon, the weather being very calm and ſerene. It was of a conical figure, and deſtroyed fifty-five cottages in the fall. Fifteen perſons, together with about an hundred beaſts, were alſo cruſhed beneath its ruins, which covered an extent of a good league ſquare. The duſt it occaſioned, inſtantly covered all the neighbourhood in darkneſs. The heaps of rubbiſh were more than three hundred feet high. They ſtopped the current of a river that ran along the plain, which now is formed into ſeveral new and deep lakes. There appeared through the whole of this rubbiſh, none of thoſe ſubſtances that ſeemed to indicate that this diſruption had been made by means of ſubterraneous fires. Moſt probably, the baſe of this rocky mountain was rotted and decayed; and thus fell, without any extraneous violence." In the ſame manner, in the year 1618, the town of Pleurs, in France, was buried beneath a rocky mountain, at the foot of which it was ſituated.

Theſe accidents, and many more that might be enumerated of the ſame kind, have been produced by various cauſes: by earthquakes, as in the mountain at Cajeta; or by being decayed at the bottom, as at Diableret. But the moſt general way is, by the foundation of one part of the mountain being hollowed by waters, and, thus, wanting a ſupport, breaking from the other. Thus it generally has been found in the great chaſms in the Alps; and thus it almoſt always is known in thoſe diſruptions of hills, which are known by the name of land-ſlips. Theſe are nothing more than the ſliding down of an higher piece of ground, diſrooted from its ſituation by ſubterraneous inundations, and ſettling itſelf upon the plain below.

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* Buffon, vol. ii. p. 364. † Hiſt de l' Academie des Sciences, p. 4, an. 1715.

There is not an appearance in all Nature that ſo much aſtoniſhed our anceſtors, as theſe land-ſlips. In fact, to behold a large upland, with its houſes, its corn, and cattle, at once looſened from its place, and floating, as it were, upon the ſubjacent water; to behold it quitting its ancient ſituation, and travelling forward like a ſhip in queſt of new adventures; this is certainly one of the moſt extraordinary appearances that can be imagined; and to a people, ignorant of the powers of Nature, might well be conſidered as a prodigy. Accordingly, we find all our old hiſtorians mentioning it as an omen of approaching calamities. In this more enlightened age, however, its cauſe is very well known; and, inſtead of exciting ominous apprehenſions in the populace, it only gives riſe to ſome very ridiculous law-ſuits among them, about whoſe the property ſhall be; whether the land which has thus ſlipt, ſhall belong to the original poſſeſſor, or to him upon whoſe grounds it has encroached and ſettled. What has been the determination of the judges, is not ſo well known, but the circumſtances of the ſlips have been minutely and exactly deſcribed.

In the lands of Slatberg*, in the kingdom of Iceland, there ſtood a declivity, gradually aſcending for near half a mile. In the year 1713, and on the 10th of March, the inhabitants perceived a crack on its ſide, ſomewhat like a furrow made with a plough, which they imputed to the effects of lightning, as there had been thunder the night before. However, on the evening of the ſame day, they were ſurpriſed to hear an hideous confuſed noiſe iſſuing all round from the ſide of the hill; and their curioſity being raiſed, they reſorted to the place. There, to their amazement, they found the earth, for near five acres, all in gentle motion, and ſliding down the hill uponthe ſubjacent plain. This motion continued the remaining part of the day, and the whole night; nor did the noiſe ceaſe during the whole time; proceeding, probably, from the attrition of the ground beneath. The day following, however, this ſtrange journey down the hill ceaſed entirely; and above an acre of the meadow below, was found covered with what before compoſed a part of the declivity.

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* Phil. Tranſ. vol. iv. p. 250.

However, theſe ſlips, when a whole mountain's ſide ſeems to deſcend, happen but very rarely. There are ſome of another kind, however, much more common; and, as they are always ſudden, much more dangerous. Theſe are ſnow-ſlips, well known, and greaty dreaded by travellers. It often happens, that when ſnow has long been accumulated on the tops and on the ſides of mountains, it is born down the precipice, either by means of tempeſts, or its own melting. At firſt, when looſened, the volume in motion is but ſmall; but it gathers as it continues to roll; and, by the time it has reached the habitable parts of the mountain, is generally grown of enormous bulk. Wherever it rolls, it levels all things in its way; or buries them in unavoidable deſtruction. Inſtead of rolling, it ſometimes is found to ſlide along from the top; yet even thus it is generally as fatal as before. Nevertheleſs, we have had an inſtance, a few years ago, of a ſmall family in Germany, that lived for above a fortnight beneath one of theſe ſnow-ſlips. Altho' they were buried during that whole time, in utter darkneeſs, and under a bed of ſome hundred feet deep, yet they were luckily taken out alive; the weight of the ſnow being ſupported by a beam that kept up the roof; and nouriſhment being ſupplied them by the milk of an aſs, if I remember right, that was buried under the ſame ruin.

But it is not the parts, alone, that are thus found to ſubſide, whole mountains have been known totally to diſappear. Pliny tells us*, that in his own time, the lofty mountain of

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* P in. l. ii. cap. 93.

Cybotus, together with the city of Eurites, were ſwallowed by an earthquake. The ſame fate, he ſays, attended Phlegium, one of the higheſt mountains in Æthiopia; which, after one night's concuſſion, was never ſeen more. In more modern times, a very noted mountain in the Molucca iſlands, known by the name of the *Peak*, and remarkable for being ſeen at a very great diſtance from ſea, was ſwallowed by an earthquake; and nothing but a lake was left in the place where it ſtood. Thus, while ſtorms and tempeſts are levelled againſt mountains above, earthquakes and waters are undermining them below. All our hiſtories talk of their deſtruction; and very few new ones (if we except Mount Cenere, and one or two ſuch heaps of cinders) are produced. If mountains, therefore were of ſuch great utility as ſome philoſophers make them to mankind, it would be a very melancholy conſideration that ſuch benefits were diminiſhing every day. But the truth is, the valleys are fertilized by that earth which is waſhed from their ſides; and the plains become richer, in proportion as the mountains decay.

CHAP. XIII.

OF WATER.

IN contemplating Nature, we ſhall often find the ſame ſubſtances poſſeſſed of contrary qualities, and producing oppoſite effects. Air, which liquifies one ſubſtance, dries up another. That fire which is ſeen to burn up the deſert, is often found, in other places, to aſſiſt the luxuriance of vegetation; and water, which next to fire, is the moſt fluid ſubſtance upon earth, nevertheleſs, gives all other bodies their firmneſs and durability; ſo that every element ſeems to be a powerful ſervant, capable either of good or ill, and only awaiting external direction, to become the friend or the enemy of mankind. Theſe oppoſite qualities, in this ſubſtance in particular, have not failed to excite the admiration and inquiry of the curious.

That water is the moſt fluid penetrating body, next to fire, and the moſt difficult to confine, is inconteſtibly proved by a variety of experiments. A veſſel through which water cannot paſs, may be ſaid to retain any thing. It may be objected indeed, that ſyrups, oils, and honey, leak through ſome veſſels that water cannot paſs through; but this is far from being the reſult of the greater tenuity and fineneſs of their parts; it is owing to the roſin wherewith the wood of ſuch veſſels abounds, which oils and ſyrups have a power of diſſolving; ſo that theſe fluids, inſtead of finding their way, may more properly be ſaid to eat their way through the veſſels that contain them. However, water will at laſt find its way even through theſe; for it is known to eſcape through veſſels of every ſubſtance, glaſs only excepted. Other bodies may be found to make their way out more readily indeed; as air, when it finds a vent, will eſcape at once; and quickſilver, becauſe of its weight, quickly penetrates through whatever chinky veſſel confines it: but water, tho' it operates more ſlowly, yet always finds a more certain iſſue. As, for inſtance, it is well known that air will not paſs through leather; which water will very readily penetrate. Air alſo may be retained in a bladder; but water will quickly ooze through. And thoſe who drive this to the greateſt degree of preciſion, pretend to ſay, that it will paſs through pores ten times ſmaller than air can do. Be this as it may, we are very certain that its parts are ſo ſmall that they have been actually driven through the pores of gold. This has been proved by the famous Florentine experiment, in which a quantity of water was ſhut up in an hollow ball of gold, and then preſſed with an huge force by ſcrews, during which the fluid was ſeen to ooze out through the pores of the metal, and to ſtand, like a dew, upon its ſurface."

As water is thus penetrating, and its parts thus minute, it may eaſily be ſuppoſed that they enter into the compoſition of all bodies, vegetable, animal, and foſſil. This every chymiſt's experiences convinces him of; and the mixture is the more obvious, as it can always be ſeparated, by a gentle heat, from thoſe ſubſtances with which it had been united. Fire, as was ſaid, will penetrate where water cannot paſs; but then it is not ſo eaſily to be ſeparated. But there is ſcarce any ſubſtance from which its water cannot be divorced: The parings or filings of lead, tin, and antimony, by diſtillation, yield water plentifully: the hardeſt ſtones, ſea-ſalt, nitre, vitriol, and ſulphur, are found to conſiſt chiefly of water; into which they reſolve by force of fire. "All birds, beaſts, and fiſhes," ſays Newton, "inſects, trees, and vegetables, with their parts, grow from water; and, by putrifaction, return to water again." In ſhort, almoſt every ſubſtance that we ſee, owes its texture and firmneſs to the parts of water that mix with its earth; and, deprived of this fluid, it becomes a maſs of ſhapeleſs duſt and aſhes.

From hence we ſee, as was above hinted, that this moſt fluid body, when mixed with others, gives them conſiſtence and form. Water, by being mixed with earth and aſhes, and formed into a veſſel, when baked before the fire, becomes a copel, remarkable for this, that it will bear the utmoſt force of the hotteſt furnace that art can contrive. So the Chineſe earth, of which porcelane is made, is nothing more than an artificial compoſition of earth and water, united by heat; and which a greater degree of heat could eaſily ſeparate. Thus we ſee a body, extremely fluid of itſelf, in ſome meaſure aſſuming a new nature, by being united with others; we ſee a body, whoſe fluid and diſſolving qualities are ſo obvious, giving conſiſtence and hardneſs to all the ſubſtances of the earth.

From conſiderations of this kind, Thales, and many of the ancient philoſophers, held that all things were made of water. In order to confirm this opinion, Helmont made an experiment, by diveſting a quantity of earth of all its oils and ſalts, and then putting this earth, ſo prepared, into an earthen pot, which nothing but rain water could enter, and planting a willow therein; this vegetable, ſo planted, grew up to a conſiderable height and bulk, merely from the accidental aſperſion of rain-water; while the earth, in which it was planted, received no ſenſible diminution. From this experiment, he concluded, that water was the only nouriſhment of the vegetable tribe; and that vegetables, being the nouriſhment of animals, all organized ſubſtances, therefore, owed their ſupport and being only to water. But this has been ſaid by Woodward to be all a miſtake: for he ſhews, that water being impregnated with earthy particles, is only the conveyer of ſuch ſubſtances into the pores of vegetables, ra-

rather than an increaſer of them, by its own bulk: he ſhews that water is ever found to afford ſo much leſs nouriſhment, in proportion as it is purified by diſtillation. A plant in diſtilled water, will not grow ſo faſt as in water not diſtilled; and if the ſame be diſtilled three or four times over, the plant will ſcarce grow at all, or receive any nouriſhment from it. So that water, as ſuch, does not ſeem the proper nouriſhment of vegetables, but only the vehicle thereof, which contains the nutritious particles, and carries them through all parts of the plant. Water, in its pure ſtate, may ſuffice to extend or ſwell the parts of a plant, but affords vegetable matter in a moderate proportion.

However this be, it is agreed on all ſides, that water, ſuch as we find it, is far from being a pure ſimple ſubſtance. The moſt genuine we know is mixed with exhalations and diſſolutions of various kinds; and no expedient that has been hitherto diſcovered, is capable of purifying it entirely. If we filter and diſtil it a thouſand times, according to Boerhaave, it will ſtill depoſe a ſediment: and by repeating the proceſs we may evaporate it entirely away, but can never totally remove its impurities. Some, however, aſſert, that water, properly diſtilled, will have no ſediment*; and that the little white ſpeck which is found at the bottom of the ſtill, is a ſubſtance that enters from without. Kircher uſed to ſhew in his muſæum, a phial of water, that had been kept for fifty years, hermetically ſealed†; during which it had depoſed no ſediment, but continued as tranſparent as when firſt it was put in. How far, therefore, it may be brought to a ſtate of purity by diſtillation, is unknown; but we very well know, that all ſuch water as we every where ſee, is a bed in which plants, minerals, and animals, are all found confuſedly floating together.

Rain-water, which is a fluid of Nature's own diſtilling, and which has been raiſed ſo high by evaporation, is, nevertheleſs, a very mixed and impure ſubſtance. Exhalations of all kinds, whether ſalts, ſulphurs, or metals, make a part of its ſubſtance, and tend to increaſe its weight. If we gather the water that falls, after a thunder-clap, in a ſultry ſummer's day, and let it ſettle, we ſhall find a real ſalt ſticking at the bottom. In winter, however, its impure mixtures are fewer, but ſtill may be ſeparated by diſtillation. But as to that which is generally caught pouring from the tops of houſes, it is particularly foul, being impregnated with the ſmoke of the chimnies, the vapour of the ſlates or tiles, and with other impurities that birds and animals may have depoſited there. Beſides, though it ſhould be ſuppoſed free from all theſe, it is mixed with a quantity of air, which, after being kept for ſome time, will be ſeen to ſeparate.

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* Hill's Hiſtory of Foſſils.

† Hermetically ſealing a glaſs veſſel, means no more than heating the mouth of the phial red hot; and thus when the glaſs is become pliant, ſqueezing the mouth together with a pair of pincers, and then twiſting it ſix or ſeven times round, which effectually cloſes it up.

Spring-water is next, in point of purity. This, according to Dr. Halley, is collected from the air itſelf; which being ſated with water, and coming to be condenſed by the evening's cold, is driven againſt the tops of the mountains, where being condenſed, and collected, it trickles down by the ſides, into the cavities of the earth; and running for a while underground, bubbles up in fountains upon the plain. This having made but a ſhort circulation, has generally had no long time to diſſolve or imbibe any foreign ſubſtances by the way.

River-water is generally more foul than the former.—Wherever the ſtream flows, it receives a tincture from its channel. Plants, minerals, and animals, all contribute to add to its impurities: ſo that ſuch as live at the mouths of great rivers, generally are ſubject to all thoſe diſorders which contaminated and unwholeſome waters are known to produce. Of all the river-water in the world, that of the Indus and the Thames is ſaid to be the moſt light and wholeſome.

The moſt impure freſh-water that we know, is that of ſtagnated pools and lakes, which, in ſummer, may be more properly conſidered as a jelly of floating inſects, than a collection of water. In this, millions of little reptiles, undiſturbed by any current, which might cruſh their frames to pieces, breed and engender. The whole teems with ſhapeleſs life, and only grows more fruitful by increaſing putrifaction.

Of the purity of all theſe waters, the lightneſs and not the tranſparency, ought to be the teſt. Water may be extremely clear and beautiful to the eye, and yet very much impregnated with mineral particles. In fact, ſea-water is the moſt tranſparent of any, and yet is well known to contain a large mixture of ſalt and bitumen. On the contrary, thoſe waters which are lighteſt, have the feweſt diſſolutions floating in them; and may, therefore, be the moſt uſeful for all the purpoſes of life. But, after all, though much has been ſaid upon this ſubject, and although waters have been weighed with great aſſiduity, to determine their degree of ſalubrity, yet neither this, nor their curdling with ſoap, nor any other philoſophical ſtandard whatſoever, will anſwer the purpoſes of true information. Experience alone ought to determine the uſeful or noxious qualities of every ſpring; and experience aſſures us, that different kinds of water are adapted to different conſtitutions. An inconteſtible proof of this, are the many medicinal ſprings throughout the world, whoſe peculiar benefits are known to the natives of their reſpective countries. Theſe are of various kinds, according to the different minerals with which they are impregnated; hot, ſaline, ſulphureous, bituminous, and oily. But the account of theſe will come moſt properly under that of the ſeveral minerals by which they are produced.

After all, therefore, we muſt be contented with but an impure mixture for our daily beverage. And yet, perhaps, this very mixture may often be more ſerviceable to our health than that of a purer kind. We know that it is ſo with regard to vegetables; and why not, alſo, in general, to man? Be this as it will, if we are deſirous of having water in its greateſt purity, we are ordered, by the curious in this particular to diſtil it from ſnow, gathered upon the tops of the higheſt mountains, and to take none but the outer and ſuperficial part thereof. This we muſt be ſatisfied to call pure water; but even this is far ſhort of the pure unmixed philoſophical element; which, in reality, is no where to be found.

As water is thus mixed with foreign matter, and often the repoſitory of minute animals or vegetable ſeeds, we need not be ſurpriſed that, when carried to ſea, it is always found to putrify. But we muſt not ſuppoſe that it is the element itſelf which thus grows putrid, and offenſive, but the ſubſtances with which it is impregnated. It is true, the utmoſt precautions are taken to deſtroy all vegetable and animal ſubſtances that may have previouſly been lodged in it, by boiling; but, notwithſtanding this, there are ſome that will ſtill ſurvive the operation; and others that find their way during the time of its ſtowage. Seamen, therefore, aſſure us, that their water is generally found to putrefy twice, at leaſt, and ſometimes three times, in a long voyage. In about a month after it has been at ſea, when the bung is taken out of the caſk, it ſends up a noiſome and dangerous vapour which would take fire upon the application of a candle *. The whole body of the water then is found replete with little worm-like inſects, that float, with great briſkneſs, through all its parts. Theſe generally live for about a couple of days; and then dying, by depoſiting their ſpoils, for a while increaſe the putrefaction. After a time, the heavier parts of theſe ſinking to the bottom, the lighter float, in a ſcum, at the top; and this is what mariners call, the water's purging itſelf. There is ſtill, however, another race of inſects, which are bred, very probably, from the ſpoils of the former; and produce, after ſome time, ſimilar appearances: theſe dying, the water is then thought to change no more. However, it very often happens, eſpecially in hot climates, that nothing can drive theſe nauſeous inſects from the ſhip's ſtore of water. They often increaſe to a very diſagreeable and frightful ſize, ſo as to deter the mariner, though parching with thirſt, from taſting that cup which they have contaminated.

This water, as thus deſcribed, therefore, is a very different fluid from that ſimple elementary ſubſtance upon which philoſophical theories have been founded; and concerning the nature of which there have been ſo many diſputes. Elementary water is no way compounded; but is without taſte, ſmell, or colour; and incapable of being diſcerned by any of the ſenſes, except the touch. This is the famous diſſolvent of the chymiſts, into which, as they have boaſted, they can reduce all bodies; and which makes up all other ſubſtances, only by putting on a different diſguiſe. In ſome forms, it is fluid, tranſparent, and evaſive, of the touch; in others, hard, firm, and elaſtic. In ſome, it is ſtiffened by cold; in others, diſſolved by fire. According to them, it only aſſumes external ſhapes from accidental cauſes; but the mountain is as

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* Phil. Tranſ. vol. v. part ii. p. 71.

much a body of water, as the cake of ice that melts on its brow; and even the philoſopher himſelf is compoſed of the ſame materials with the cloud or meteor which he contemplates.

Speculation ſeldom reſts when it begins. Others, diſallowing the univerſality of this ſubſtance, will not allow that in a ſtate of nature there is any ſuch thing as water at all.—"What aſſumes the appearance," ſay they, "is nothing more than melted ice. Ice is the real element of Nature's making; and when found in a ſtate of fluidity, it is then in a ſtate of violence. All ſubſtances are naturally hard; but ſome more readily melt with heat than others. It requires a great heat to melt iron: a ſmaller heat will melt copper: ſilver, gold, tin, and lead, melt with ſmaller ſtill: ice, which is a body like the reſt, melts with a very moderate warmth; and quickſilver melts with the ſmalleſt warmth of all. Water, therefore, is but ice kept in continual fuſion; and ſtill returning to its former ſtate, when the heat is taken away." Between theſe oppoſite opinions, the controverſy has been carried on with great ardour, and much has been written on both ſides: and yet, when we come to examine the debate, it will probably terminate in this queſtion, whether cold or heat firſt began their operations upon water? This is a fact of very little importance, if known; and, what is more, it is a fact we can never know.

Indeed, if we examine into the operations of cold and heat upon water, we ſhall find that they produce ſomewhat ſimilar effects. Water dilates in its bulk, by heat, to a very conſiderable degree; and, what is more extraordinary, it is likewiſe dilated by cold, in the ſame manner.

If water be placed over a fire, it grows gradually larger in bulk, as it becomes hot, until it begins to boil; after which no art can either increaſe its bulk or its heat. By increaſing the fire, indeed, it may be more quickly evaporated away; but its heat and its bulk ſtill continue the ſame. By the expanding of this fluid, by heat, philoſophers have found a way to determine the warmth, or the coldneſs of other bodies: for if put into a glaſs tube, by its ſwelling and riſing, it ſhews the quantity of heat in the body to which it is applied; by its contracting and ſinking, it ſhews the abſence of the ſame. Inſtead of uſing water in this inſtrument, which is called a thermometer, they now make uſe of ſpirit of wine, which is not apt to freeze, and which is endued even with a greater expanſion, by heat, than water. The inſtrument conſiſts of nothing more than a hollow ball of glaſs, with a long tube growing out of it. This being partly filled with ſpirits of wine, tinctured red, ſo as to be ſeen when it riſes, the ball is plunged into boiling water, which making the ſpirit within expand and riſe in the tube, the water marks the greateſt height to which it aſcends; at this point the tube is to be broken off, and then hermetically ſealed, by melting the glaſs with a blow-pipe: a ſcale being placed by the ſide, completes the thermometer. Now as the fluid expands or condenſes with heat or cold, it will riſe and fall in the tube in proportion; and the degree or quantity of aſcent or deſcent will be ſeen in the ſcale.

No fire, as was ſaid, can make water hotter, after it begins to boil. We can, therefore, at any time be ſure of an equable certain heat; which is that of boiling water, which is invariably the ſame. The certainty of ſuch a heat is not leſs uſeful than the inſtrument that meaſures it. It affords a ſtandard, fixed, degree of heat over the whole world; boiling water being as hot in Greenland, as upon the coaſts of Guinea. One fire is more intenſe than another; of heat there are various degrees; but boiling water is a heat every where the ſame, and eaſily procurable.

As heat thus expands water, ſo cold, when it is violent enough to freeze the ſame, produces exactly the ſame effect, and expands it likewiſe. Thus water is acted upon in the ſame manner by two oppoſite qualities; being dilated by both. As a proof that it is dilated by cold, we have only to obſerve the ice floating on the ſurface of a pond, which it would not do were it not dilated, and grown more bulky, by freezing, than the water, which remains unfroze. Mr. Boyle, however, put the matter paſt a doubt, by a variety of experiments*. Having poured a proper quantity of water into a ſtrong earthen veſſel, he expoſed it, uncovered, to the open air, in froſty nights; and obſerved, that continually the ice reached higher than the water, before it was frozen,

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* Boyle, vol. i. p. 610.

He filled alſo a tube with water, and ſtopped both ends with wax: the water, when froze, was found to puſh out the ſtopples from both ends; and a rod of ice appeared at each end of the tube, which ſhewed how much it was ſwollen by the cold within.

From hence, therefore, we may be very certain of the cold's dilating of the water; and experience alſo ſhews, that the force of this expanſion has been found as great as any which heat has been found to produce. The touch-hole of a ſtrong gun-barrel being ſtopped, and a plug, of iron forcibly driven into the muzzle, after the barrel had been filled with water, it was placed in a mixture of ice and ſalt; the plug, though ſoldered to the barrel, at firſt gave way, but being fixed in more firmly, within a quarter of an hour the gun-barrel burſt with a loud noiſe, and blew up the cover of the box wherein it lay. Such is its force in an ordinary experiment. But it has been known to burſt cannons, filled with water, and then left to freeze; for the cold congealing the water, and the ice ſwelling, it became irreſiſtible. The burſting of rocks, by froſt, which is frequent in the Northern climates, and is ſometimes ſeen in our own, is an equal proof of the expanſion of congealed water. For having, by ſome means inſinuated itſelf into the body of the rock, it has remained there till the cold was ſufficient to affect it by congelation. But when once frozen, no obſtacle is able to confine it from dilating; and, if it cannot otherwiſe find room, the rock muſt burſt aſunder.

This alteration in the bulk of water, might have ſerved as a proof that it was capable of being compreſſed into a narrower ſpace than it occupied before; but, till of late, water was held to be incompreſſible. The general opinion was, that no art whatſoever could ſqueeze it into a narrower compaſs; that no power on earth, for inſtance, could force a pint of water into a veſſel that held an hair's-breadth leſs than a pint. And this, ſaid they, appears from the famous Florentine experiment; where the water, rather than ſuffer compreſſure, was ſeen to ooze through the pores of the ſolid metal; and, at length, making a cleft in the ſide, ſpun out with great vehemence. But later trials have proved that water is very compreſſible, and partakes of that elaſticity which every other body poſſeſſes in ſome degree. Indeed, had not mankind been dazzled by the brilliancy of one inconcluſive experiment, there were numerous reaſons to convince them of its having the ſame properties with other ſubſtances. Ice, which is water in another ſtate, is very elaſtic. A ſtone, flung ſlantingly along the ſurface of a pond, bounds from the water ſeveral times; which ſhews it to be elaſtic alſo. But the trials of Mr. Canton have put this paſt all doubt; which being ſomewhat ſimilar to thoſe of the great Boyle, who preſſed it with weights properly applied, carry ſufficient conviction.

What has been hitherto related, is chiefly applicable to the element of water alone; but its fluidity is a property that it poſſeſſes in common with ſeveral other ſubſtances, in other reſpects greatly differing from it. That quality which gives riſe to the definition of a fluid, namely, that its parts are in a continual inteſtine motion, ſeems extremely applicable to water. What the ſhapes of thoſe parts are, it would be vain to attempt to diſcover. Every trial only ſhews the futility of the attempt; all we find is, that they are extremely minute; and that they roll over each other with the greateſt eaſe. Some, indeed, from this property alone, have not heſitated to pronounce them globular; and we have, in all our hydroſtatical books, pictures of theſe little globes in a ſtate of ſliding and rolling over each other. But all this is merely the work of imagination; we know that ſubſtances of any kind, reduced very ſmall, aſſume a fluid appearance, ſomewhat reſembling that of water. Mr. Boyle, after finely powdering and ſifting a little dry powder of plaiſter of Paris, put it in a veſſel over the fire, where it ſoon began to boil like water, exhibiting all the motions and appearances of a boiling liqour. Although but a powder, the parts of which we know are very different from each other, and juſt as accident has formed them, yet it heaved in great waves, like water. Upon agitation, a heavy body will ſink to the bottom, and a light one emerge to the top. There is no reaſon, then, to ſuppoſe the figure of the parts of water round, ſince we ſee their fluidity very well imitated by a compoſition, the parts of which are of various forms and ſizes. The ſhape of the parts of water, therefore, we muſt be content to continue ignorant of. All we know is, that earth, air, and fire, conduce to ſeparate the parts from each other.

Earthy ſubſtances divide the parts from each other, and keep them aſunder. This diviſion may be ſo great, that the water will entirely loſe its fluidity thereby. Mud, potter's clay, and dried bricks, are but ſo many different combinations of earth and water; each ſubſtance in which the parts of water are moſt ſeparated from each other, appearing to be the moſt dry. In ſome ſubſtances, indeed, where the parts of water are greatly divided, as in porcelane, for inſtance, it is no eaſy matter to recover and bring them together again; but they continue in a manner fixed and united to the manufactured clay. This circumſtance led Doctor Cheney into a very peculiar ſtrain of thinking. He ſuſpected that the quantity of water, on the ſurface of the earth, was daily decreaſing. For, ſays he, ſome parts of it are continually joined to vegetable, animal, and mineral ſubſtances, which no art can again recover. United with theſe, the water loſes its fluidity; for if, continues he, we ſeparate a few particles of any fluid, and faſten them to a ſolid body, or keep them aſunder, they will be fluid no longer. To produce fluidity, a conſiderable number of ſuch particles are required; but here they are cloſe, and deſtitute of their natural properties. Thus, according to him, the world is growing every day harder and harder, and the earth firmer and firmer; and there may come a time when every object around us may be ſtiffened in univerſal frigidity! However, we have cauſes enough of anxiety in this world already, not to add this prepoſterous concern to the number.

That air alſo contributes to divide the parts of water, we can have no manner of doubt of; ſome have even diſputed whether water be not capable of being turned into air. However, though this cannot be allowed, it muſt be granted, that it may be turned into a ſubſtance which greatly reſembles air (as we have ſeen in the experiment of the œolipile) with all its properties; except that, by cold, this new made air may be condenſed again into water.

But of all the ſubſtances which tend to divide the parts of water, fire is the moſt powerful. Water, when heated into ſteam, acquires ſuch force, and the parts of it tend to fly off from each other with ſuch violence, that no earthly ſubſtance we know of is ſtrong enough to confine them. A ſingle drop of water, converted into ſteam, has been found capable of raiſing a weight of twenty tons; and would have raiſed twenty thouſand, were the veſſel confining it ſufficiently ſtrong, and the fire below increaſed in proportion.

From this eaſy yielding of its parts to external preſſure, ariſes the art of determining the ſpecific gravity of bodies by plunging them in water; with many other uſeful diſcoveries in that part of natural philoſophy, called *hydroſtatics*. The laws of this ſcience, which Archimedes began, and Paſcal, with ſome other of the moderns, have much improved, rather belongs to experimental than to natural hiſtory. However, I will take leave to mention ſome of the moſt ſtriking paradoxes in this branch of ſcience, which are well confirmed by experiment, as rendered univerſal by theory. It would, indeed, be unpardonable, while diſcourſing on the properties of water, to omit giving ſome account of the manner in which it ſuſtains ſuch immenſe bulks as we ſee floating upon its ſoft and yielding ſurface: how ſome bodies, that are known to ſink at one time, ſwim with eaſe, if their ſurface be enlarged: how the heavieſt body, even gold itſelf, may be made to ſwim upon water; and how the lighteſt, ſuch as cork, ſhall remain ſunk at the bottom: how the pouring in of a ſingle quart of water, will burſt a hogſhead hooped with iron: and how it aſcends, in pipes, from the valley, to travel over the mountain: theſe are circumſtances that are at firſt ſupriſing; but, upon a ſlight conſideration, loſe their wonder.

*In order to conceive the manner in which all theſe wonders are effected, we muſt begin by obſerving that water is poſſeſſed of an invariable property, which has not hitherto been mentioned; that of always keeping its ſurface level and even. Winds, indeed, may raiſe it into waves; or art ſpurt it up in fountains; but ever, when left to itſelf, it ſinks into a ſmooth even ſurface, of which no one part is higher than another. If I ſhould pour water, for inſtance, into the arm of a pipe of the ſhape of the letter U, the fluid would riſe in the other arm juſt to the ſame height; becauſe, otherwiſe, it would not find its level, which it invariably maintains. A pipe bending from one hill down into the valley, and riſing by another, may be conſidered as a tube of this kind, in which the water, ſinking in one arm, riſes to maintain its level in the other. Upon this principle all water-pipes depend; which can never raiſe the water higher than the fountain from which they proceed.

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* In the above ſketch, the manner of demonſtrating uſed by Monſieur D'Alambert is made uſe of, as the moſt obvious, and the moſt ſatisfactory. Vide Eſſai ſur, &c.

Again, let us ſuppoſe for a moment, that the arms of the pipe already mentioned, may be made long or ſhort at pleaſure; and let us ſtill further ſuppoſe, that there is ſome obſtacle at the bottom of it, which prevents the water pouring into one arm, from riſing in the other. Now it is evident, that this obſtacle at the bottom will ſuſtain a preſſure from the water in one arm, equal to what would make it riſe in the other; and this preſſure will be great, in proportion as the arm filled with water is tall. We may, therefore, generally conclude, that the bottom of every veſſel is preſſed by a force, in proportion to the height of the water in that veſſel. For inſtance, if the veſſel filled with water be forty feet high, the bottom of that veſſel will ſuſtain ſuch a preſſure as would raiſe the ſame water forty feet high, which is very great. From hence we ſee how extremely apt our pipes that convey water to the city are to burſt; for deſcending from an hill of more than forty feet high, they are preſſed by the water contained in them, with a force equal to what would raiſe it more than forty feet high; and that this is ſometimes able to burſt a wooden pipe, we can have no room to doubt of.

Still recurring to our pipe, let us ſuppoſe one of its arms ten times as thick as the other; this will produce no effect whatſoever upon the obſtacle below, which we ſuppoſed hindering its riſe in the other arm; becauſe, how thick ſoever the pipe may be, its contents would only riſe to its own level; and it will, therefore, preſs the obſtacle with a force equal thereto. We may, therefore, univerſally conclude, that the bottom of any veſſel is preſſed by its water, not as it is broad or narrow, but in proportion as it is high. Thus the water contained in a veſſel not thicker than my finger, preſſes its bottom as forcibly as the water contained in an hogſhead of an equal height; and, if we made holes in the bottoms of both, the water would burſt out as forceful from the one as the other. Hence we may, with great eaſe, burſt an hogſhead with a ſingle quart of water; and it has been often done. We have only*, for this, to place an hogſhead on one end, filled with water; we then bore an hole in its top, into which we plant a narrow tin pipe, of about thirty feet high: by pouring a quart of water into this, at the top, as it continues to riſe higher in the pipe, it will preſs more forcibly on the bottom and ſides of the hogſhead below, and at laſt burſt it.

Still returning to our ſimple inſtrument of demonſtration. If we ſuppoſe the obſtacle at the bottom of the pipe to be moveable, ſo as that the force of the water can puſh it up into the other arm; ſuch a body is quickſilver, for inſtance. Now, it is evident, that the weight of water weighing down upon this quickſilver in one arm, will at laſt preſs it up in the other arm; and will continue to preſs it upward, until the fluid in both arms be upon a par. So that here we actually ſee quickſilver, the heavieſt ſubſtance in the world, except gold, floating upon water, which is but a very light ſubſtance.

When we ſee water thus capable of ſuſtaining quickſilver, we need not be ſurpriſed that it is capable of floating much lighter ſubſtances, ſhips, animals, or timber. When any thing floats upon water, we always ſee that a part of it ſinks in the ſame. A cork, a ſhip, a buoy, each buries itſelf a bed on the ſurface of the water; this bed may be conſidered as ſo much water diſplaced; the water will, therefore, loſe ſo much of its own weight, as is equal to the weight of that bed of water which it diſplaces. If the body be heavier than a ſimilar bulk of water, it will ſink; if lighter, it will ſwim. Univerſally, therefore, a body plunged in water, loſes as much of its weight as is equal to the weight of a body of water of its own bulk. Some light bodies, therefore, ſuch as cork, loſe much of their weight, and therefore ſwim; other more ponderous bodies ſink, becauſe they are heavier than their bulk of water.

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* Nollet's Lectures.

Upon this ſimple theorem entirely depends the art of weighing metals hydroſtatically. I have a guinea, for inſtance, and deſire to know whether it be pure gold: I have weighed it in the uſual way with another guinea, and find it exactly of the ſame weight, but ſtill I have ſome ſuſpicion, from its greater bulk, that it is not pure. In order to determine this, I have nothing more to do than to weigh it in water with that ſame guinea that I know to be good, and of the ſame weight; and this will inſtantly ſhew the difference; for the true ponderous metal will ſink, and the falſe bulky one will be ſuſtained in proportion to the greatneſs of its ſurface. Thoſe whoſe buſineſs it is to examine the purity of metals, have a balance made for this purpoſe, by which they can preciſely determine which is moſt ponderous, or, as it is expreſſed, which has the greateſt ſpecific gravity. Seventy-one pounds and an half of quick ſilver is found to be equal in bulk to a hundred pound weight of gold. In the ſame proportion ſixty of lead, fifty-four of ſilver, forty-ſeven of copper, forty-five of braſs, forty-two of iron, and thirty-nine of tin, are each equal to an hundred pounds of the ſame moſt ponderous of all metals.

This method of preciſely determining the purity of gold, by weighing in water, was firſt diſcovered by Archimedes, to whom mankind have been indebted for many uſeful diſcoveries. Hiero, king of Sicily, having ſent a certain quantity of gold to be made into a crown, the workman, it ſeems, kept a part for his own uſe, and ſupplied the deficiency with a baſer metal. His fraud was ſuſpected by the king, but could not be detected; till applying to Archidemes, he weighed the crown in water; and, by this method, informed the king of the quantity of gold which was taken away.

It has been ſaid, that all fluids endeavour to preſerve their level; and, likewiſe, that a body preſſing on the ſurface, tended to deſtroy that level. From hence, therefore, it will eaſily be inferred, that the deeper any body ſinks, the greater will be the reſiſtance of the depreſſed fluid beneath. It will be aſked, therefore, as the reſiſtance increaſes in proportion as the body deſcends, how comes the body, after it is got a certain way, to ſink at all? The anſwer is obvious. From the fluid above preſſing it down with almoſt as great a force as the fluid beneath preſſes it up. Take away, by any art, the preſſure of the fluid from above, and let only the reſiſtance of the fluid from below be ſuffered to act, and after the body is got down very deep, the reſiſtance will be inſuperable. To give an inſtance: A ſmall hole opens in the bottom of a ſhip at ſea, forty feet we will ſuppoſe below the ſurface of the water; through this the water burſts up with great violence; I attempt to ſtop it with my hand, but it puſhes the hand violently away. Here the hand is, in fact, a body attempting to ſink upon water, at a depth of forty feet, with the preſſure from above taken away. The water, therefore, will overcome my ſtrength; and it will continue to burſt in till it has got to its level: if I ſhould then dive into the hold, and clap my hand upon the opening, as before, I ſhould perceive no force acting againſt my hand at all; for the water above preſſes the hand as much down againſt the hole, as the water without preſſes it upward. For this reaſon, alſo, when we dive to the bottom of the water, we ſuſtain a very great preſſure from above, it is true, but it is counteracted by the preſſure from below; and the whole acting uniformly on the ſurface of the body, wraps us cloſe round without injury.

As I have deviated thus far, I will juſt mention one or two properties more, which water, and all ſuch like fluids, is found to poſſeſs. And firſt, their aſcending in veſſels which are emptied of air, as in our common pumps for inſtance. The air, however, being the agent in this caſe, we muſt previouſly examine its properties, before we undertake the explanation. The other property to be mentioned is, that of their aſcending in ſmall capillary tubes. This is one of the moſt extraordinary and inſcrutable appearances in nature. Glaſs tubes may be drawn, by means of a lamp, as fine as a hair; ſtill preſerving their hollow within. If one of theſe be planted in a veſſel of water, or ſpirit of wine, the liquor will immediately be ſeen to aſcend; and it will riſe higher, in proportion as the tube is ſmaller; a foot, two feet, and more. How does this come to paſs? Is the air the cauſe? No: the liquor riſes, although the air be taken away. Is attraction the cauſe? No: for quickſilver does not aſcend, which it otherwiſe would. Many have been the theories of experimental philoſophers to explain this property. Such as are fond of travelling in the regions of conjecture, may conſult Hawkſbee, Morgan, Jurin, or Watſon, who have examined the ſubject with great minuteneſs. Hitherto, however, nothing but doubts, inſtead of knowledge, have been the reſult of their inquiries. It will not, therefore, become us to enter into the minuteneſs of the inquiry, when we have ſo many greater wonders to call our attention away.

CHAP. XIV.

OF THE ORIGIN OF RIVERS.

"THE ſun ariſeth, and the ſun goeth down, and pants for "the place from whence he aroſe. All things are filled with "labour, and man cannot utter it. All rivers run into the "ſea, yet the ſea is not full. Unto the place whence the "rivers come, thither they return again. The eye is not ſatisfied with ſeeing, nor the ear with hearing*." Thus ſpeaks the wiſeſt of the Jews. And at ſo early a period was the curioſity of man employed in obſerving theſe great circulations of Nature. Every eye attempted to explain thoſe appearances; and every philoſopher who has long thought upon the ſubject, ſeems to give a peculiar ſolution. The inquiry whence rivers are produced; whence they derive thoſe unceaſing ſtores of water, which continually enrich the world with fertility and verdure; has been variouſly conſidered, and divided the opinions of mankind more than any other topic in natural hiſtory.

In this conteſt the various champions may be claſſed under two leaders, M. De La Hire, who contends that rivers muſt be ſupplied from the ſea, ſtrained through the pores of the earth; and Dr. Halley, who has endeavoured to demonſtrate that the clouds alone are ſufficient for the ſupply.—Both ſides have brought in mathematics to their aid; and have ſhewn that long and laborious calculations can at any time be made to obſcure both ſides of a queſtion.

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*Eccleſiaſtes, chap. i. 5, 7, 8

De La Hire* begins his proofs, that rain-water evaporated from the ſea, is inſufficient for the production of rivers; by ſhewing that rain never penetrates the ſurface of the earth above ſixteen inches. From thence he infers, that it is impoſſible for it, in many caſes, to ſink ſo as to be found at ſuch conſiderable depths below. Rain-water, he grants, is often ſeen to mix with rivers, and to ſwell their currents; but a much greater part of it evaporates. "In fact," continues he, "if we ſuppoſe the earth every where covered with water, evaporation alone would be ſufficient to carry off two feet nine inches of it in a year: and yet we very well know, that ſcarce nineteen inches of rain-water falls in that time; ſo that evaporation would carry off a much greater quantity is ever known to deſcend. The ſmall quantity of rain-water that falls is, therefore, but barely ſufficient for the purpoſes of vegetation. Two leaves of a fig-tree have been found, by experiment, to imbibe from the earth, in five hours and a half, two ounces of water. This implies the great quantity of fluid that muſt be exhauſted in the maintenance of one ſingle plant. Add to this, that the waters of the river Rungis will, by calculation, riſe to fifty inches; and the whole country from whence they are ſupplied never receives fifty inches in the year by rain. Beſides this, there are many ſalt ſprings, which are known to proceed immediately from the ſea, and are ſubject to its flux and reflux. In ſhort, wherever we dig beneath the ſurface of the earth, except in a very few inſtances, water is to be found: and it is by this ſubterraneous water, that ſprings and rivers, nay, a great part of vegetation itſelf, is ſupported. It is this ſubterraneous water which is raiſed into ſteam, by the internal heat of the earth, that feeds plants. It is this ſubterraneous water that diſtils through its interſtices; and there, cooling, forms fountains. It is this, that, by the addition of rains, is increaſed into rivers, and pours plenty over the whole earth."

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* Hiſt. de l'Acad. 1713, p. 56.

On the other ſide of the queſtion*, it is aſſerted, that the vapours which are exhaled from the ſea, and driven by the winds upon land, are more than ſufficient to ſupply not only plants with moiſture, but alſo to furniſh a ſufficiency of water to the greateſt rivers. For this purpoſe, an eſtimate has been made of the quantity of water emptied at the mouths of the greateſt rivers; and of the quantity alſo raiſed from the ſea by evaporation; and it has been found, that the latter by far exceeds the former. This calculation was made by Mr. Marriotte. By him it was found, upon receiving ſuch rain as fell in a year, in a proper veſſel fitted for that purpoſe, that, one year with another, there might fall about twenty inches of water upon the ſurface of the earth, throughout Europe. It was alſo computed that the river Seine, from its ſource to the city of Paris, might cover an extent of ground, that would ſupply it annually with above ſeven billions of cubic feet of this water, formed by evaporation. But upon, computing the quantity which paſſed through the arches of one of its bridges in a year, it was found to amount only to two hundred and eighty millions of cubic feet, which is not above the ſixth part of the former number. Hence, therefore, it appears, that this river may receive a ſupply brought to it by the evaporated waters of the ſea, ſix times greater than what it gives back to the ſea by its current; and therefore, evaporation is more than ſufficient for maintaining the greateſt rivers, and ſupplying the purpoſes alſo of vegetation.

In this manner the ſea ſupplies ſufficient humidity to the air for furniſhing the earth with all neceſſary moiſture. One part of its vapours fall upon its own boſom, before they arrive upon land. Another part is arreſted by the ſides of mountains, and is compelled, by the riſing ſtream of air to mount upward towards its ſummits. Here it is preſently precipitated, dripping down by the crannies of the ſtone. In ſome places, entering into the caverns of the mountain, it gathers in thoſe receptacles, which being once filled, all the reſt overflows; and breaking out by the ſides of the hills, forms ſingle ſprings. Many of theſe run down by the vallies, or guts, between the ridges of the mountain, and, coming to unite, form little rivulets or brooks; many of theſe meeting in one common valley, and gaining the plain ground, being grown leſs rapid, become a river: and many of theſe uniting, make ſuch vaſt bodies of water, as the Rhine, the Rhone, and the Danube.

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* Phil. Tranſ. vol. ii. p. 128.

There is ſtill a third part, which falls upon the lower grounds, and furniſhes plants with their wonted ſupply.—But the circulation does not reſt even here; for it is again exhaled into vapour by the action of the ſun; and afterward returned to that great maſs of waters whence it firſt aroſe. "This," adds Dr. Halley, "ſeems the moſt reaſonable hypotheſis; and much more likely to be true, than that of thoſe who derive all ſprings from the filtering of the ſea-waters, through certain imaginary tubes or paſſages within the earth; ſince it is well known that the greateſt rivers have their moſt copious fountains the moſt remote from the ſea *."

This ſeems the moſt general opinion; and yet, after all, it is ſtill preſſed with great difficulties; and there is ſtill room to look out for a better theory. The perpetuity of many ſprings, which always yield the ſame quantity when the leaſt rain or vapour is afforded, as well as when the greateſt, is a ſtrong objection. Derham † mentions a ſpring at Upminſter, which he could never perceive by his eye to be diminiſhed, in the greateſt droughts, even when all the ponds in the country, as well as an adjoinining brook, have been dry for ſeveral months together. In the rainy ſeaſons, alſo, it was never overflowed; except ſometimes, perhaps, for an hour or ſo, upon the immiſſion of the external rains. He, therefore, juſtly enough concludes, that had this ſpring its origin from rain or vapour, there would be found an increaſe or decreaſe of its water, correſponding to the cauſes of its production.

Thus the reader, after having been toſſed from one hypotheſis to another, muſt at laſt be content to ſettle in conſcious ignorance. All that has been written upon this ſubject, affords him rather ſomething to ſay, than ſomething to think;

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* Phil. Tranſ. vol. ii. p. 128.

† Derham Phyſico-Theol.

ſomething rather for others than for himſelf. Varenius, indeed, although he is at a loſs for the origin of rivers, is by no means ſo as to their formation. He is pretty poſitive that all rivers are artificial. He boldly aſſerts, that their channels have been originally formed by the induſtry of man. His reaſons are, that when a new ſpring breaks forth, the water does not make itſelf a new channel, but ſpreads over the adjacent land. "Thus," ſays he, "men are obliged to direct its courſe; or, otherwiſe, Nature would never have found one." He enumerates many rivers that are certainly known, from hiſtory, to have been dug by men. He alleges, that no ſalt-water rivers are found, becauſe men did not want ſalt-water; and as for ſalt, that was procurable at a leſs expence than digging a river for it. However, it coſts a ſpeculative man but a ſmall expence of thinking to form ſuch an hypotheſis. It may, perhaps, engroſs the reader's patience to detain him longer upon it.

Nevertheleſs, though Philoſophy be thus ignorant, as to the production of rivers, yet the laws of their motion, and the nature of their currents, have been very well explained. The Italians have particularly diſtinguiſhed themſelves in this reſpect; and it is chiefly to them that we are indebted for the improvement*.

All rivers have their ſource either in mountains, or elevated lakes; and it is in their deſcent from theſe that they acquire that velocity which maintains their future current. At firſt their courſe is generally rapid and headlong; but it is retarded in its journey, by the continual friction againſt its banks, by the many obſtacles it meets to divert its ſtream, and by the plains generally becoming more level as it approaches towards the ſea.

If this acquired velocity be quite ſpent, and the plain through which the river paſſes is entirely level, it will, notwithſtanding, ſtill continue to run from the perpendicular preſſure of the water, which is always in exact proportion to the depth. This perpendicular preſſure is nothing more than the weight of the upper waters preſſing the lower out of their places, and, conſequently, driving them forward, as they cannot recede againſt the ſtream. As this preſſure is greateſt in the deepeſt parts of the river, ſo we generally find the middle of the ſtream moſt rapid; both becauſe it has the greateſt motion thus communicated by the preſſure, and the feweſt obſtructions from the banks on either ſide.

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* S. Guglielmini della Natura de Fiumi, paſſim.

Rivers thus ſet into motion are almoſt always found to make their own beds. Where they find the bed elevated, they wear its ſubſtance away, and depoſit the ſediment in the next hollow, ſo as in time to make the bottom of their channels even. On the other hand, the water is continually gnawing and eating away the banks on each ſide; and this with more force as the current happens to ſtrike more directly againſt them. By theſe means, it always has a tendency to render them more ſtraight and parallel to its own courſe. Thus it continues to rectify its banks, and enlarge its bed; and, conſequently, to diminiſh the force of its ſtream, till there becomes an equilibrium between the force of the water, and the reſiſtance of its banks, upon which both will remain without any further mutation. And it is happy for man that bounds are thus put to the eroſion of the earth by water; and that we find all rivers only dig and widen themſelves but to a certain degree*.

In thoſe plains† and large valleys where great rivers flow, the bed of the river is uſually lower than any part of the valley. But it often happens, that the ſurface of the water is higher than many of the grounds that are adjacent to the banks of the ſtream. If, after inundations, we take a view of ſome rivers, we ſhall find their banks appear above water, at a time that all the adjacent valley is overflown. This proceeds from the frequent depoſition of mud, and ſuch like ſubſtances upon the banks, by the rivers frequently overflowing; and thus, by degrees, they become elevated above the plain; and the water is often ſeen higher alſo.

Rivers, as every body has ſeen, are always broadeſt at the mouth, and grow narrower towards their ſource. But what is leſs known, and probably more deſerving curioſity, is, that they run in a more direct channel as they immediately leave their ſources; and that their ſinuoſities and turnings become more numerous as they proceed. It is a certain ſign among the ſavages of North America, that they are near the ſea when they find the rivers winding, and every now and then changing their direction. And this is even now become an indication to the Europeans themſelves, in their journies through thoſe trackleſs foreſts. As thoſe ſinuoſities, therefore, increaſe as the river approaches the ſea, it is not to be wondered at that they ſometimes divide, and thus diſembogue by different channels. The Danube diſembogues into the Euxine by ſeven mouths; the Nile by the ſame number; and the Wolga by ſeventy.

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* Guglielmini della Natura de Fiumi, paſſim.

† Buffon, de Fleuves, paſſim, vol. ii.

The currents* of rivers are to be eſtimated very differently from the manner in which thoſe writers who have given us mathematical theories on this ſubject, repreſent them. They found their calculations upon the ſurface being a perfect plain from one bank to the other: but this is not the actual ſtate of Nature; for rivers, in general, riſe in the middle; and this convexity is greateſt in proportion as the rapidity of the ſtream is greater. Any perſon to be convinced of this, need only lay his eye, as nearly as he can, on a level with the ſtream, and looking acroſs to the oppoſite bank, he will perceive the river in the midſt to be elevated conſiderably above what it is at the edges. This riſing, in ſome rivers, is often found to be three feet high; and is ever increaſed in proportion to the rapidity of the ſtream. In this caſe, the water in the midſt of the current loſes a part of its weight, from the velocity of its motion; while that at the ſides, for the contrary reaſon ſinks lower. It ſometimes, however, happens, that this appearance is reverſed; for when tides are found to flow up with violence againſt the natural current of the water, the greateſt rapidity is then found at the ſides of the river, as the water there leaſt reſiſts the influx from the ſea. On thoſe occaſions, therefore, the river preſents a concave rather than a convex ſurface; and, as in the former caſe, the middle waters roſe in a ridge, in this caſe they ſink in a furrow.

The ſtream in all rivers is more rapid in proportion as its channel is diminiſhed. For inſtance, it will be much ſwifter where it is ten yards broad, than where it is twenty; for the force behind ſtill puſhing the water forward, when it comes to the narrow part, it muſt make up by velocity what it wants in room.

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* Buffon, de Fleuves, paſſim, vol. ii.

It often happens that the ſtream of a river is oppoſed by one of its jutting banks, by an iſland in the midſt, the arches of a bridge, or ſome ſuch obſtacle. This produces not unfrequently a back current; and the water having paſſed the arch with great velocity, puſhes the water on each ſide of its direct current. This produces a ſide current, tending to the bank; and not unfrequently a whirlpool; in which a large body of waters are circulated in a kind of cavity, ſinking down in the middle. The central point of the whirlpool is always loweſt, becauſe it has the leaſt motion: the other parts are ſupported, in ſome meaſure, by the violence of theirs, and, conſequently riſe higher, as their motion is greater; ſo that towards the extremity of the whirlpool muſt be higher, than towards the centre.

If the ſtream of a river be ſtopped at the ſurface, and yet be free below; for inſtance, if it be laid over by a bridge of boats, there will then be a double current; the water at the ſurface will flow back, while that at the bottom will proceed with increaſed velocity. It often happens that the current at the bottom is ſwifter than at the top, when, upon violent land-floods, the weight of waters towards the ſource, preſſes the waters at the bottom, before it has had time to communicate its motion to the ſurface. However, in all other caſes, the ſurface of the ſtream is ſwifter than the bottom, as it is not retarded by rubbing over the bed of the river.

It might be ſuppoſed that bridges, dams, and other obſtacles in the current of a river, would retard its velocity. But the difference they make is very inconſiderable. The water, by theſe ſtoppages, gets an elevation above the object; which, when it has ſurmounted, it gives a velocity that recompences the former delay. Iſlands and turnings alſo retard the courſe of the ſtream but very inconſiderably; any cauſe which diminiſhes the quantity of the water, moſt ſenſibly diminiſhes the force and the velocity of the ſtream.

An increaſe* of water in the bed of the river always increaſes its rapidity; except in caſes of inundation. The inſtant the river has overflowed its banks, the velocity of its current is always turned that way, and the inundation is perceived to continue for ſome days; which it would not otherwiſe do, if, as ſoon as the cauſe was diſcontinued, it acquired its former rapidity.

A violent ſtorm, that ſets directly up againſt the courſe of the ſtream, will always retard, and ſometimes entirely ſtop its courſe. I have ſeen an inſtance of this, when the bed of a large riever was left entirely dry for ſome hours, and fiſh were caught among the ſtones at the bottom.

Inundations are generally greater towards the ſource of rivers than farther down; becauſe the current is generally ſwifter below than above; and that for the reaſons already aſſigned.

A little river† may be received into a large one, without augmenting either its width or depth. This, which at firſt view ſeems a paradox, is yet very eaſily accounted for. The little river, in this caſe, only goes towards increaſing the ſwiftneſs of the larger, and putting its dormant waters into motion. In this manner the Venetian branch of the Po was puſhed on by the Ferareſe branch and that of Panaro, without any enlargement of its breadth or depth from theſe acceſſions.

A river tending to enter another, either perpendicularly, or in an oppoſite direction, will be diverted, by degrees, from that direction; and be obliged to make itſelf a more favourable entrance downward, and more conſpiring with the ſtream of the former.

The union of two rivers into one, makes it flow the ſwifter; ſince the ſame quantity of water, inſtead of rubbing againſt four ſhores, now only rubs againſt two. And, beſides, the current being deeper, becomes, of conſequence, more fitted for motion.

With reſpect to the places from whence rivers proceed, it may be taken for a general rule, that the largeſt‡ and higheſt mountains ſupply the greateſt and moſt extenſive

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[*] Buffon, vol. ii. p. 62.

[†] Guglielmini, ibid.

[‡] Doctor Halley.

rivers. It may alſo remarked, in whatever direction the ridge of the mountain runs, the river takes an oppoſite courſe. If the mountain, for inſtance, ſtretches from north to ſouth, the river runs from eaſt to weſt; and ſo contrariwiſe. Theſe are ſome of the moſt generally received opinions with regard to the courſe of rivers; however, they are liable to many exceptions; and nothing but an actual knowledge of each particular river can furniſh us with an exact theory of its current.

The largeſt rivers of Europe are, firſt, the Wolga, which is about ſix hundred and fifty leagues in length, extending from Reſchow to Aſtrachan. It is remarkable of this river, that it abounds with water during the ſummer months of May and June; but all the reſt of the year is ſo ſhallow as ſcarce to cover its bottom, or allow a paſſage for loaded veſſels that trade up its ſtream. It was up this river that the Engliſh attempted a trade into Perſia, in which they were ſo unhappily diſappointed, in the year 1741. The next in order is the Danube. The courſe of this is about four hundred and fifty leagues, from the mountains of Switzerland to the Black Sea. It is ſo deep between Buda and Belgrade, that the Turks and Chriſtians have fleets of men of war upon it; which frequently engaged, during the laſt war between the Ottomans and the Auſtrians: however, it is unnavigable further down, by reaſon of its cataracts, which prevent its commerce into the Black Sea. The Don, or Tanais, which is four hundred leagues from the ſource of that branch of it called the *Soſna*, to its mouth in the Euxine ſea. In one part of its courſe, it approaches near the Wolga; and Peter the Great had actually begun a canal, by which he intended joining thoſe two rivers; but this he did not live to finiſh. The Nieper, or Boriſthenes, which riſes in the middle of Muſcovy, and runs a courſe of three hundred and fifty leagues, to empty itſelf into the Black Sea. The old Coſſacks inhabit the banks and iſlands of this river; and frequently croſs the Black Sea, to plunder the maritime places on the coaſts of Turkey. The Dwina; which takes its riſe in a province of the ſame name in Ruſſia, then runs a courſe of three hundred leagues, and diſembogues into the White Sea, a little below Archangel.

The largeſt rivers of Aſia are, the Hoanho, in China, which is eight hundred and fifty leagues in length, computing from its ſource at Raja Ribron, to its mouth in the Gulph of Changi. The Jeniſca of Tartary, about eight hundred leagues in length, from the lake Selinga, to the Icy Sea. This river is, by ſome, ſuppoſed to ſupply moſt of that great quantity of drift wood which is ſeen floating in the ſeas, near the Artic circle. The Oby, of five hundred leagues running from the lake of Kila into the Northern Sea. The Amour, in Eaſtern Tartary, whoſe courſe is about five hundred and ſeventy-five leagues, from its ſource to its entrance into the ſea of Kamtſkatka. The Kiam, in China, five hundred and fifty leagues in length. The Ganges, one of the moſt noted rivers in the world, and about as long as the former. It riſes in the mountains which ſeparate India from Tartary; and running through the dominions of the Great Mogul, diſcharges itſelf by ſeveral mouths into the bay of Bengal. It is not only eſteemed by the Indians for the depth, and pureneſs of its ſtream, but for a ſuppoſed ſanctity which they believe to be in its waters. It is viſited annually by ſeveral hundred thouſand pilgrims, who pay their devotions to the river as to a god; for ſavage ſimplicity is always known to miſtake the bleſſings of the Deity, for the Deity himſelf. They carry their dying friends from diſtant countries, to expire on its banks; and to be buried in its ſtream. The water is loweſt in April or May; but the rains beginning to fall ſoon after, the flat country is overflowed for ſeveral miles, till about the end of September; the waters then begin to retire, leaving a prolific ſediment behind, that enriches the ſoil, and, in a few days time, gives a luxuriance to vegetation, beyond what can be conceived by an European. Next to this may be reckoned the ſtill more celebrated river Euphrates. This riſes from two ſources, northward of the city Erzerum, in Turcomania, and unites about three days journey below the ſame, from whence, after performing a courſe of five hundred leagues, it falls into the gulph of Perſia, fifty miles below the city of Baſſora in Arabia. The river Indus is extended from its ſource to its diſcharge into the Arabian ſea, four hundred leagues.

The largeſt rivers of Africa are, the Senegal, which runs a courſe of not leſs than eleven hundred leagues, comprehending the Niger, which ſome have ſuppoſed to fall into it. However later accounts ſeem to affirm that the Niger is loſt in the ſands, about three hundred miles up from the weſtern coaſts of Africa. Be this as it may, the Senegal is well known to be navigable for more than three hundred leagues up the country; and how much higher it may reach is not yet diſcovered, as the dreadful fatality of the inland parts of Africa, not only deter curioſity, but even avarice, which is a much ſtronger paſſion. At the end of laſt war, of fifty Engliſhmen that were ſent to the factory at Galam, a place taken from the French, and nine hundred miles up the river, only one returned to tell the fate of his companions, who were deſtroyed by the climate. The celebrated river Nile is ſaid to be nine hundred and ſeventy leagues, from its ſource among the mountains of the Moon, in Upper Æthiopia, to its opening into the Mediterranean ſea. The ſources of this river were conſidered as inſcrutable by the ancients; and the cauſes of its periodical inundation were equally known. They have both been aſcertained by the miſſionaries who have travelled into the interior parts of Æthiopia. The Nile takes its riſe in the kingdom of Gojam*, from a ſmall aperture on the top of a mountain, which, though not above a foot and a half over, yet was unfathomable. This fountain, when arrived at the foot of the mountain, expands into a river; and, being joined by others, forms a lake thirty leagues long, and as many broad; from this, its channel, in ſome meaſure, winds back to the country where it firſt began; from thence, precipitating by frightful cataracts, it travels through a variety of deſert regions, equally formidable, ſuch as Amhara, Olaca, Damot, and Xaoa. Upon its arrival in the kingdom of Upper Egypt, it runs through a rocky channel, which ſome late travellers have miſtaken for its cataracts. In the beginning of its courſe, it receives many leſſer rivers into it; and Pliny was miſtaken, in ſaying that it received none. In the beginning alſo of its courſe, it has many windings; but, for above three hundred leagues from the ſea, it runs in a direct line. Its annual overflowings ariſe from a very obvious cauſe, which is almoſt univerſal with the great rivers that take their ſource near the line. The rainy ſeaſon, which is periodical in thoſe climates, flood the rivers; and as this always happens in our ſummer, ſo the Nile is at that time overflown. From theſe inundations, the inhabitants of Egypt derive happineſs and plenty; and, when the river does not ariſe to its accuſtomed heights, they prepare for an indifferent harveſt. It begins to overflow about the ſeventeenth of June; it generally continues to augment for forty days, and decreaſes in about as many more. The time of encreaſe and decreaſe, however, is much more inconſiderable now then it was among the ancients. Herodotus informs us, that it was an hundred days riſing, and as many falling; which ſhews that the inundation was much greater at that time than at preſent. Mr. Buffon* has aſcribed the preſent diminution, as well to the leſſening of the Mountains of the Moon, by their ſubſtance having ſo long been waſhed down with the ſtream, as to the riſing of the earth in Egypt, that has for ſo many ages received this extraneous ſupply. But we do not find, by the buildings that have remained ſince the times of the ancients, that the earth is much raiſed ſince then. Beſides the Nile in Africa, we may reckon the Zara, and the Coanza, from the greatneſs of whoſe openings into the ſea, and the rapidity of whoſe ſtreams, we form an eſtimate of the great diſtance from whence they come. Their courſes, however, are ſpent in watering deſerts and ſavage countries, whoſe poverty or fierceneſs have kept ſtrangers away.

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* Kircher, Mund. Subt. vol. ii. p. 72.

But of all parts of the world, America, as it exhibits the moſt lofty mountains, ſo alſo it ſupplies the largeſt rivers. The foremoſt of theſe is the great river Amazons, which, from its ſource in the lake of Lauricocha, to its diſcharge into the Weſtern Ocean, performs a courſe of more than twelve hundred leagues†. The breadth and depth of this river is anſwerable to its vaſt length; and, where its width is moſt contracted, its depth is augmented in proportion. So great is the body of its waters, that other rivers, though before the objects of admiration, are loſt in its boſom. It proceeds, after their junction, with its uſual appearance, without any viſible change in its breadth or rapidity; and, if we may ſo expreſs it, remains great without oſtentation. In ſome places it diſplays its whole magnificence, dividing into ſeveral large branches, and encompaſſing a multitude of iſlands; and, at length, diſcharging itſelf into the ocean, by a channel of an hundred and fifty miles broad. Another river, that may almoſt rival the former, is the St. Lawrence, in Canada, which riſing in the lake Aſſiniboils, paſſes from one lake to another, from Chriſtineaux to Alempigo; from thence to lake Superior; thence to the lake Hurons; to lake Erie; to lake Ontario; and, at laſt, after a courſe of nine hundred leagues, pours their collected waters into the Atlantic Ocean. The river Miſſiſſippi is of more than ſeven hundred leagues in length, beginning at its ſource near the lake Aſſiniboils, and ending at its opening into the gulph of Mexico. The river Plate runs a length of more than eight hundred leagues from its ſource in the river Parana, to its mouth. The river Oroonoko is ſeven hundred and fifty-five leagues in length, from its ſource near Paſto, to its diſcharge into the Atlantic Ocean.

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* Buffon, vol. ii. p. 82.

† Ulloa, vol. i. p. 388.

Such is the amazing length of the greateſt rivers; and even in ſome of theſe, the moſt remote ſources very probably yet continue unknown. In fact, if we conſider the number of rivers which they receive, and the little acquaintance we have with the regions through which they run, it is not to be wondered at that geographers are divided concerning the ſources of moſt of them. As among a number of roots by which nouriſhment is conveyed to a ſtately tree, it is difficult to determine preciſely that by which the tree is chiefly ſupplied; ſo among the many branches of a great river, it is equally difficult to tell which is the original. Hence it may eaſily happen, that a ſmaller branch is taken for the capital ſtream; and its runnings are purſued, and delienated, in prejudice of ſome other branch that better deſerved the name and the deſcription. In this manner * in Europe, the Danube is known to receive thirty leſſer rivers: the Wolga,

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* Buffon, vol. ii. p. 74.

thirty-two or thirty-three. In Aſia, the Hohanno receives thirty-five; the Jeniſca above ſixty; the Oby as many; the Amour about forty; the Nanquin receives thirty rivers; the Ganges twenty; and Euphrates about eleven. In Africa, the Senegal receives more than twenty rivers; the Nile receives not one for five hundred leagues upwards, and then only twelve or thirteen. In America, the river Amazons receives above ſixty, and thoſe very conſiderable; the river St. Lawrence about forty, counting thoſe which fall into its lakes; the Miſſiſſippi receives forty; and the river Plate above fifty.

I mentioned the inundations of the Ganges and the Nile, but almoſt every other great river whoſe ſource lies within the tropics, have their ſtated inundations alſo. The river Pegu has been called, by travellers, the Indian Nile, becauſe of the ſimilar overflowings of its ſtream: this it does to an extent of thirty leagues on each ſide; and ſo fertilizes the ſoil, that the inhabitants ſend great quantities of rice into other countries, and have ſtill abundance for their own conſumption. The river Senegal has likewiſe its inundations, which cover the whole flat country of Negroland, beginning and ending much about the ſame time with thoſe of the Nile; as, in fact, both rivers riſe from the ſame mountains. But the difference between the effects of the inundations in each river, is remarkable: in the one, it diſtributes health and plenty; in the other, diſeaſes, famine, and death. The inhabitants along the torrid coaſts of the Senegal, can receive no benefit from any additional manure the river may carry down to their ſoil, which is, by Nature, more than ſufficiently luxuriant; or, even if they could, they have not induſtry to turn it to any advantage. The banks, therefore, of the river, lies uncultivated, overgrown with rank and noxious herbage, and infeſted with thouſands of animals of various malignity. Every new flood only tends to increaſe the rankneſs of the ſoil, and to provide freſh ſhelter for the creatures that infeſt it. If the flood continues but a few days longer than uſual, the improvident inhabitants, who are driven up in the higher grounds, want proviſions, and a famine enſues. When the river begins to return into its channel, the humidity and heat of the air are equally fatal; and the carcaſſes of infinite numbers of animals, ſwept away by the inundation, putrifying in the ſun, produce a ſtench that is almoſt inſupportable. But even the luxuriance of the vegetation becomes a nuiſance. I have been aſſured, by perſons of veracity who have been up the river Senegal, that there are ſome plants growing along the coaſt, the ſmell of which is ſo powerful, that it is hardly to be endured.' It is certain, that all the ſailors and ſoldiers who have been at any of our factories there, aſcribe the unwholeſomeneſs of the voyage up the ſtream, to the vegetable vapour. However this be, the inundations of the rivers in this wretched part of the globe, contribute ſcarce any advantage, if we except the beauty of the proſpects which they afford. Theſe, indeed, are finiſhed beyond the utmoſt reach of art: a ſpacious glaſſy river, with its banks here and there fringed to the very ſurface by the mangrove-tree, that grows down into the water, preſents itſelf to view; lofty foreſts of various colours, with openings between, carpeted with green plants, and the moſt gaudy flowers; beaſts and animals, of various kinds, that ſtand upon the banks of the river, and, with a ſort of wild curioſity, ſurvey the mariners as they paſs, contribute to heighten the ſcene. This is the ſketch of an African proſpect; which delights the eye, even while it deſtroys the conſtitution.

Beſide theſe annually periodical inundations, there are many rivers that overflow at much ſhorter intervals. Thus moſt of thoſe in Peru and Chili have ſcarce any motion by night; but upon the appearance of the morning ſun, they reſume their former rapidity: this proceeds from the mountain ſnows, which melting with the heat, increaſe the ſtream, and continue to drive on the current while the ſun continues to diſſolve them. Some rivers alſo flow with an even ſteady current, from their ſource to the ſea; others flow with greater rapidity, their ſtream being poured down in a cataract, or ſwallowed by the ſands, before they reach the ſea.

The rivers of thoſe countries that have been leaſt inhabited, are uſually more rocky, uneven, and broken into water-falls or cataracts, than thoſe where the induſtry of man has been more prevalent. Wherever man comes, Nature puts on a milder appearance: the terrible and the ſublime, are exchanged for the gentle and the uſeful; the cataract is ſloped away inte a placid ſtream; and the banks become more ſmooth and even*. It muſt have required ages to render the Rhone or the Loire navigable; their beds muſt have been cleaned and directed; their inequalities removed; and by a long courſe of induſtry, Nature muſt have been taught to conſpire with the deſires of her controller. Every one's experience muſt have ſupplied inſtances of rivers thus being made to flow more evenly, and more beneficially to mankind; but there are ſome whoſe currents are ſo rapid, and falls ſo precipitate, that no art can obviate; and that muſt for ever remain as amazing inſtances of inccorrigible Nature.

Of this kind are the cataracts of the Rhine; one of which I have ſeen exhibit a very ſtrange appearance; it was that at Schathauſen, which was frozen quite acroſs, and the water ſtood in columns where the cataract had formerly fallen. The Nile, as was ſaid, has its cataracts. The river Vologda, in Ruſſia, has two. The river Zara, in Africa, has one near its ſource. The river Velino, in Italy, has a cataract of above an hundred and fifty feet perpendicular. Near the city of Gottenburgh†, in Sweden, the river ruſhes down from a prodigious high precipice, into a deep pit, with terrible a noiſe, and ſuch dreadful force, that thoſe trees deſigned for the maſts of ſhips, which are floated down the river, uſually are turned upſide down in there fall, and often are ſhattered to pieces, by being daſhed againſt the ſurface of the water in the pit; this occurs if the maſts fall ſideways upon the water; but if they fall endways, they dive ſo far under water, that they diſappear for a quarter of an hour, or more: the pit into which they are thus plunged, has been often ſounded with a line of ſome hundred fathoms long, but no ground has been found hitherto. There is alſo a cataract at Powerſcourt, in Ireland, in which, if I am rightly informed, the water falls three hundred feet perpendicular; which is a greater deſcent than that of any other cataract in any part of the world. There is a cataract at Albany, in the province of New-York, which pours its ſtream fifty feet perpendicular. But of all the cataracts in the world, that of Niagara, in Canada, if we conſider the great body of water that falls, muſt be allowed to be the greateſt, and the moſt aſtoniſhing.

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* Buffon, vol. i. p. 90.

† Phil. Tranſ. vol. ii. p. 525.

This amazing fall of water is made by the river St. Lawrence, in its paſſage from the lake Erie into the lake Ontario. We have already ſaid that St. Lawrence was one of the largeſt rivers in the world; and yet the whole of its waters are here poured down, by a fall of an hundred and fifty feet perpendicular. It is not eaſy to bring the imagination to correſpond with the greatneſs of the ſcene; a river, extremely deep and rapid, and that ſerves to drain the waters of almoſt all North America into the Atlantic ocean, is here poured precipitately down a ledge of rocks, that riſe, like a wall, acroſs the whole bed of its ſtream. The width of the river a little above, is near three quarters of a mile broad; and the rocks, where it grows narrower, are four hundred yards over. Their direction is not ſtraight acroſs, but hollowing inwards like a horſe-ſhoe; ſo that the cataract, which bends to the ſhape of the obſtacle, rounding inwards, preſents a kind of theatre the moſt tremendous in Nature. Juſt in the middle of this circular wall of waters, a little iſland, that has braved the fury of the current, preſents one of its points, and divides the ſtream at top into two; but it unites again long before it has got to the bottom. The noiſe of the fall is heard at ſeveral leagues diſtance; and the fury of the waters at the bottom of their fall, is inconceivable. The daſhing produces a miſt that riſes to the very clouds; and that produces a moſt beautiful rainbow, when the ſun ſhines. It may eaſily be conceived, that ſuch a cataract quite deſtroys the navigation of the ſtream; and yet ſome Indian canoes, as it is ſaid, have been known to venture down it with ſafety.

Of thoſe rivers that loſe themſelves in the ſands, or are ſwallowed up by chaſms in the earth, we have various information. What we are told by the ancients, of the Alpheus, in Arcadia, that ſinks into the ground, and riſes again near Syracuſe, in Sicily, where it takes the name of Arethuſa, is rather more known than credited. But we have better information with reſpect to the river Tigris being loſt in this manner under Mount Taurus; of the Guadalquiver, in Spain, being buried in the ſands; of the river Greata, in Yorkſhire, running under ground, and riſing again; and even of the great Rhine itſelf, a part of which is no doubt loſt in the ſands, a little above Leyden. But it ought to be obſerved of this river, that by much the greateſt part arrives at the ocean; for, although the ancient channel which fell into the ſea, a little to the weſt of that city, be now entirely choked up, yet there are ſtill a number of ſmall canals, that carry a great body of waters to the ſea; and, beſides, it has alſo two very large openings, the Lech, and the Waal, below Rotterdam, by which it empties itſelf abundantly.

Be this as it will, nothing is more common in ſultry and ſandy deſerts, than rivers being thus either loſt in the ſands, or entirely dried up by the ſun. And hence we ſee, that under the line, the ſmall rivers are but few; for ſuch little ſtreams as are common in Europe, and which with us receive the name of rivers, would quickly evaporate, in thoſe parching and extenſive deſerts. It is even confidently aſſerted, that the great river Niger is thus loſs before it reaches the ocean; and that its ſuppoſed mouths, the Gambia, and the Senegal, are diſtinct rivers, that come a vaſt way from the interior parts of the country. It appears, therefore, that the rivers under the line are large; but it is otherwiſe at the poles*, where they muſt neceſſarily be ſmall. In that deſolate region, as the mountains are covered with perpetual ice, which melts but little, or not at all, the ſprings and rivulets are furniſhed with a very ſmall ſupply. Here, therefore, men and beaſts would periſh, and die for thirſt, if Providence had not ordered, that in the hardeſt winter, thaws ſhould intervene, which depoſit a ſmall quantity of ſnow-water in pools under the ice; and from this ſource the wretched inhabitants drain a ſcanty beverage.

Thus, whateve rquarter of the globe we turn to, we ſhall find new reaſons to be ſatisfied with that part of it in which we reſide. Our rivers furniſh all the plenty of the African ſtream, without its inundation; they have all the coolneſs of the polar rivulet, with a more conſtant ſupply; they may want the terrible magnificence of huge cataracts, or extenſive lakes, but they are more navigable, and more tranſparent; though leſs deep and rapid than the rivers of the torrid zone, they are more manageable, and only wait the will of man to take their direction. The rivers of the torrid zone, like the monarchs of the country, rule with deſpotic tyranny; profuſe in their bounties, and ungovernable in their rage. The rivers of Europe, like their kings, are the friends, and not the oppreſſors of the people; bounded by no limits, abridged in the power of doing ill, directed by human ſagacity, and only at freedom to diſtribute happineſs and plenty.

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* Crantz's Hiſtory of Greenland, vol. i. p. 41.

CHAP. XV.

OF THE OCEAN IN GENERAL; AND OF ITS SALTNESS.

IF we look upon a map of the world, we ſhall find that the ocean occupies conſiderably more of the globe, than the land is found to do. This immenſe body of waters is diffuſed round both the Old and New Continent, to the ſouth; and may ſurround them alſo to the north, for what we know, but the ice in thoſe regions has ſtopped our inquiries. Although the ocean, properly ſpeaking, is but one extenſive ſheet of waters, continued over every part of the globe, without interruption, and although no part of it is divided from the reſt, yet geographers have diſtinguiſhed it by different names; as the Atlantic or Weſtern Ocean, the Northern Ocean, the Southern Ocean, the Pacific Ocean, and the Indian Ocean. Others have divided it differently, and given other names; as the Frozen Ocean, the Inferior Ocean, or the American Ocean. But all theſe being arbitrary diſtinctions, and not of Nature's making, the naturaliſt may conſider them with indifference.

In this vaſt receptacle, almoſt all the rivers of the earth ultimately terminate; nor do ſuch great ſupplies ſeem to increaſe its ſtores; for it is neither apparently ſwollen by their tribute, nor diminiſhed by their failure; it ſtill continues the ſame. Indeed, what is the quantity of water of all the rivers and lakes in the world, compared to that contained in this great receptacle*? If we ſhould offer to make a rude eſtimate, we ſhall find that all the rivers in the world, flowing into the bed of the ſea, with a continuance of their preſent ſtores, would take up at leaſt eight hundred years to fill it to its preſent height. For, ſuppoſing the ſea to be eighty-five millions of ſquare miles in extent, and a quarter of a mile, upon an average, in depth, this, upon calculation, will give above twenty-one millions of cubic miles of water, as the contents of the whole ocean. Now, to eſtimate the quantity of water which all the rivers ſupply, take any one of them; the Po, for inſtance, the quantity of whoſe diſcharge into the ſea, is known to be one cubic mile of water in twenty-ſix days. Now it will found, upon a rude computation, from the quantity of ground the Po, with its influent ſtreams, covers, that all the rivers of the world furniſh about two thouſand times that quantity of water. In the ſpace of a year, therefore, they will have diſcharged into the ſea about twenty-ſix thouſand cubic miles of water; and not till eight hundred years, will they have diſcharged as much water as it contained in the ſea at preſent. I have not troubled the reader with the odd numbers, leſt he ſhould imagine I was giving preciſion to a ſubject that is incapable of it.

Thus great is the aſſemblage of waters diffuſed round our habitable globe; and yet, immeaſurable as they ſeem, they are moſtly rendered ſubſervient to the neceſſities and the conveniences of ſo little a being as man. Nevertheleſs, if it ſhould be aſked whether they be made for him alone, the queſtion is not eaſily reſolved. Some philoſophers have perceived ſo much analogy to man in the formation of the ocean, that they have not heſitated to aſſert its being made for him alone. The diſtribution of land and water†, ſay they, is admirable; the one being laid againſt the other ſo ſkilfully, that there is a juſt equipoiſe of the whole globe. Thus the Northern ocean balances againſt the Southern;

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* Buffon, vol. ii. p. 70.

† Derham Phyſico-Theol.

and the New Continent is an exact counter-weight to the Old. As to any objection from the ocean's occupying too large a ſhare of the globe, they contend, that there could not have been a ſmaller ſurface employed to ſupply the earth with a due ſhare of evaporation. On the other hand, ſome take the gloomy ſide of the queſtion; they either magnify* its apparent defects; or aſſert, that† what ſeems defects to us, may be real beauties to ſome wiſer order of beings. They obſerve, that multitudes of animals are concealed in the ocean, and but a ſmall part of them are known; the reſt, therefore, they fail not to ſay, were certainly made for their own benefit, and not for ours. How far either of theſe opinions be juſt, I will not preſume to determine; but if this we are certain, that God has endowed us with abilities to turn this great extent of waters to our own advantage. He has made theſe things, perhaps, for other uſes; but he has given us faculties to convert them to our own. This much agitated queſtion, therefore, ſeems to terminate here. We ſhall never know whether the things of this world have been made for our uſe; but we very well know, that we have been made to enjoy them. Let us then boldly affirm, that the earth, and all its wonders, are ours; ſince we are furniſhed with powers to force them into our ſervice. Man is the lord of all the ſublunary creation; the howling ſavage, the winding ſerpent, with all the untameable and rebellious offspring of Nature, are deſtroyed in the conteſt, or driven at a diſtance from his habitations. The extenſive and tempeſtuous ocean, inſtead of limiting or dividing his power, only ſerves to aſſiſt his induſtry, and enlarge the ſphere of his enjoyments. Its billows, and its monſters, inſtead of preſenting a ſcene of terror, only call up the courage of this little intrepid being; and the greateſt dangers that man now fears on the deep, is from his fellow creatures. Indeed, when I conſider the human race as Nature has formed them, there is but very little of the habitable globe that ſeems made for them. But when I conſider them as accumulating the experience of ages, in commanding the earth, there is nothing ſo great, or ſo terrible. What a poor contemptible being is the naked ſavage, ſtanding on the beach of the ocean, and trembling at its tumults! How little capable is he of converting its terrors into benefits; or of ſaying, Behold an element made wholly for my enjoyment! He conſiders it as an angry deity, and pays it the homage of ſubmiſſion. But it is very different when he has exerciſed his mental powers; when he has learned to find his own ſuperiority, and to make it ſubſervient to his commands. It is then that his dignity begins to appear, and that the true Deity is juſtly praiſed for having been mindful of man; for having given him the earth for his habitation, and the ſea for an inheritance.

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* Burnet's Theory, paſſim.

† Pope's Ethic Epiſtles, paſſim.

This power which man has obtained over the ocean, was at firſt enjoyed in common; and none pretended to a right in that element where all ſeemed intruders. The ſea, therefore, was open to all till the time of the Emperor Juſtinian. His ſucceſſor Leo granted ſuch as were in poſſeſſion of the ſhore, the ſole right of fiſhing before their reſpective territories. The Thracian Boſphorus was the firſt that was thus appropriated; and from that time it has been the ſtruggle of moſt of the powers of Europe to obtain an excluſive right in this element. The republic of Venice claims the Adriatic. The Danes are in the poſſeſſion of the Baltic. But the English have a more extenſive claim to the empire of all the ſeas, encompaſſing the kingdoms of England, Scotland, and Ireland; and altho' theſe have been long conteſted, yet they are now conſidered as their indiſputable property. Every one knows that the great power of the nation is exerted on this element; and that the inſtant England ceaſes to be ſuperior upon the ocean, its ſafety begins to be precarious.

It is in ſome meaſure owing to our dependence upon the ſea, and to our commerce there, that we are ſo well acquainted with its extent and figure. The bays, gulphs, currents, and ſhallows of the ocean, are much better known and examined than the provinces and kingdoms of the earth itſelf. The hopes of acquiring wealth by commerce, has carried man to much greater lengths than the deſire of gaining information could have done. In conſequence of this, there is ſcarce a ſtrait or an harbour, ſcarce a rock or a quickſand, ſcarce an inflexion of the ſhore, or the jutting of a promontory, that has not been minutely deſcribed. But as theſe preſent very little entertainment to the imagination, or delight to any but thoſe whoſe purſuits are lucrative, they need not be dwelt upon here. While the merchant and the mariner are ſolicitous in deſcribing currents and ſoundings, the naturaliſt is employed in obſerving wonders, though not ſo beneficial, yet to him of a much more important nature. The ſaltneſs of the ſea ſeems to be the foremoſt.

Whence the ſea has derived that peculiar bitteriſh ſaltneſs which we find in it, appears, by Ariſtotle, to have exerciſed the curioſity of naturaliſts in all ages. He ſuppoſed (and mankind were for ages content with the ſolution) that the ſun continually raiſed dry ſaline exhalations from the earth, and depoſited them upon the ſea; and hence, ſay his followers, the waters of the ſea are more ſalt at top than at bottom. But, unfortunately for this opinion, neither of the facts is true. Sea-ſalt is not to be raiſed by the vapours of the ſun; and ſea-water is not ſalter at the top than at the bottom. Father Bohours is of opinion that the Creator gave the waters of the ocean their ſaltneſs at the beginning; not only to prevent their corruption, but to enable them to bear greater burthens. But their ſaltneſs does not prevent their corruption; for ſtagnant ſea-water, like freſh, ſoon grows putrid: and, as for their bearing greater burthens, freſh water anſwers all the purpoſes of navigation quite as well. The eſtabliſhed opinion, therefore, is that of Boyle*, who ſuppoſes, "That the ſea's ſaltneſs is ſupplied not only from rocks or maſſes of ſalt at the bottom of the ſea, but alſo from the ſalt which the rains and rivers, and other waters, diſſolve in their paſſage thro' many parts of the earth, and at length carry with them to the ſea." But as there is a difference in the taſte of rock-ſalt found at land, and that diſſolved in the waters of the ocean, this may be produced by the plenty of nitrous and bituminous bodies that, with the ſalts, are likewiſe waſhed into that great receptacle. Theſe ſubſtances being thus once carried to the ſea, muſt for ever remain there; for they do not riſe by evaporation, ſo as to be returned back from whence they came. Nothing but the freſh waters of the ſea riſe in vapours; and all the ſaltneſs remains behind.

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* Boyle, vol. iii. p. 221.

From hence it follows, that every year the ſea muſt become more and more ſalt; and this ſpeculation Dr. Halley carries ſo far, as to lay down a method of finding out the age of the world by the ſaltneſs of its waters. "For if it be obſerved *," ſays he, "what quantity of ſalt is at preſent contained in a certain weight of water, taken up from the Caſpian Sea, for example, and, after ſome centuries, what greater quantity of ſalt is contained in the ſame weight of water, taken from the ſame place; we may conclude, that in proportion as the ſaltneſs has increaſed in a certain time, ſo much muſt it have increaſed before that time; and we may thus, by the rule of proportion, make an eſtimate of the whole time wherein the water would acquire the degree of ſaltneſs it ſhould be then poſſeſſed of." All this may be fine; however, an experiment, begun in this century, which is not to be completed till ſome centuries hence, is rather a little mortifying to modern curioſity; and, I am induced to think, the inhabitants round the Caſpian Sea, will not be apt to undertake the inquiry.

This ſaltneſs is found to prevail in every part of the ocean; and as much at the ſurface as at the bottom. It is alſo found in all thoſe ſeas that communicate with the ocean; but rather in a leſs degree.

The great lakes, likewiſe, that have no outlets nor communication with the ocean, are found to be ſalt; but ſome of them in leſs proportion. On the contrary, all thoſe lakes through which the rivers run into the ſea, however extenſive they be, are, notwithſtanding, very freſh: for the rivers do not depoſit their ſalts in the bed of the lake, but carry them with their currents into the ocean. Thus the lakes Ontario and Erie, in North America, although for magnitude they may be conſidered as inland ſeas, are, nevertheleſs, freſh-water lakes; and kept ſo by the river St. Lawrence, which paſſes through them. But thoſe lakes that have no communication with the ſea, nor any rivers going out, although they be leſs than the former, are however, always ſalt. Thus, that which goes by the name of the Dead Sea, though very ſmall, when compared to thoſe already mentioned, is ſo

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* Phil. Tranſ. vol. v. p. 218.

exceedingly ſalt, that its waters ſeem ſcarce capable of diſſolving any more. The lakes of Mexico and of Titicaca, in Peru, though of no great extent, are, nevertheleſs, ſalt; and both for the ſame reaſon.

Thoſe who are willing to turn all things to the beſt, have not failed to conſider this ſaltneſs of the ſea, as a peculiar bleſſing from Providence, in order to keep ſo great an element ſweet and wholeſome. What foundation there may be in the remark, I will not pretend to determine; but we ſhall ſhortly find a much better cauſe for its being kept ſweet, namely, its motion.

On the other hand, there have been many who have conſidered the ſubject in a different light, and have tried every endeavour to make ſalt-water freſh, ſo as to ſupply the wants of mariners in long voyages, or when exhauſted of their ordinary ſtores. At firſt it was ſuppoſed ſimple diſtillation would do; but it was ſoon found that the bitter part of the water ſtill kept mixed. It was then tried by uniting ſalt of tartar with ſea-water, and diſtilling both; but here the expence was greater than the advantage. Calcined bones were next thought of; but a hogſhead of calcined bones, carried to ſea, would take up as much room as a hogſhead of water, and was more hard to be obtained. In this ſtate, therefore, have the attempts to ſweeten ſea-water reſted; the chymiſt ſatisfied with the reality of his invention; and the mariner convinced of its being uſeleſs. I cannot, therefore, avoid mentioning a kind of ſuccedaneum which has been lately conceived to anſwer the purpoſes of freſh-water, when mariners are quite exhauſted. It is well known, that perſons who go into a warm bath, come out ſeveral ounces heavier than they went in; their bodies having imbibed a correſpondent quantity of water. This more particularly happens, if they have been previouſly debarred from drinking, or go in with a violent thirſt; which they quickly find quenched, and their ſpirits reſtored. It was ſuppoſed, that in caſe of a total failure of freſh-water at ſea, a warm bath might be made of ſea-water, for the uſe of mariners; and that their pores would thus imbibe the fluid, without any of its ſalts, which would be ſeen to cryſtallize on the ſurface of their bodies. In this manner, it is ſuppoſed, a ſufficient quantity of moiſture may be procured to ſuſtain life, till time or accident furniſh a more copious ſupply.

But, however this be, the ſaltneſs of the ſea can by no means be conſidered as a principal cauſe in preſerving its waters from putrefaction. The ocean has its currents, like rivers, which circulate its contents round the globe; and theſe may be ſaid to be the great agents that keep it ſweet and wholeſome. Its ſaltneſs alone would by no means anſwer this purpoſe: and ſome have even imagined, that the various ſubſtances with which it is mixed, rather tend to promote putreſcence than impede it. Sir Robert Hawkins, one of our moſt enlightened navigators, gives the following account of a calm, in which the ſea continuing for ſome time without motion, began to aſſume a very formidable appearance. "Were it not," ſays he, "for the moving of the ſea, by the force of winds, tides, and currents, it would corrupt all the world. The experiment of this I ſaw in the year 1590, lying with a fleet about the iſlands of Azores, almoſt ſix months; the greateſt part of which time we were becalmed. Upon which all the ſea became ſo repleniſhed with ſeveral ſorts of jellies, and forms of ſerpents, adders, and ſnakes, as ſeemed wonderful: ſome green, ſome black, ſome yellow, ſome white, ſome of divers colours; and many of them had life; and ſome there were a yard and a half, and two yards long; which, had I not ſeen, I could hardly have believed. And hereof are witneſſes all the company of the ſhips which were then preſent: ſo that hardly a man could draw a bucket of water clear of ſome corruption. In which voyage, towards the end thereof, many of every ſhip fell ſick, and began to die apace. But the ſpeedy paſſage into our country, was a remedy to the crazed, and a preſervative for thoſe that were not touched."

This ſhews, abundantly, how little the ſea's ſaltneſs was capable of preſerving it from putrefaction: but to put the matter beyond all doubt, Mr. Boyle kept a quantity of ſea-water, taken up in the Engliſh Channel, for ſome time barrelled up; and, in the ſpace of a few weeks, it began to acquire a fœtid ſmell*: He was alſo aſſured, by one of his acquaintance, who was becalmed for twelve or fourteen days in the Indian ſea, that the water for want of motion, began to ſtink; and that had it continued much longer, the ſtench would probably have poiſoned him. It is the motion, therefore, and not the ſaltneſs of the ſea, that preſerves it in its preſent ſtate of ſalubrity; and this, very probably, by daſhing and breaking in pieces the rudiments, if I may ſo call them, of the various animals that would otherwiſe breed there, and putrefy.

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* Boyle, vol. iii. p. 222.

There are ſome advantages, however, which are derived from the ſaltneſs of the ſea. Its waters being evaporated, furniſh that ſalt which is uſed for domeſtic purpoſes; and although in ſome places it is made from ſprings, and, in others dug out of mines, yet the greateſt quantity is made only from the ſea. That which is called *bay-ſalt*, (from its coming to us by the Bay of Biſcay) is a ſtronger kind, made by evaporation in the ſun: that called *common-ſalt*, is evaporated in pans over the fire, and is of a much inferior quality to the former.

Another benefit ariſing from the quantity of ſalt diſſolved in the ſea, is, that it thus becomes heavier, and, conſequently, more buoyant. Mr. Boyle, who examined the difference between ſea-water and freſh, found that the former appeared to be about a forty-fifth part heavier than the latter. Thoſe, alſo, who have had opportunities of bathing in the ſea, pretend to have experienced a much greater eaſe in ſwimming there than in freſh-water. However, as we ſee they have only a forty-fifth part more of their weight ſuſtained by it, I am apt to doubt whether ſo minute a difference can be practically perceivable. Be this as it may, as ſea-water alters in its weight from freſh, ſo it is found alſo to differ from itſelf in different parts of the ocean. In general, it is perceivable to be heavier, and, conſequently, ſalter, the nearer we approach the line*.

But there is an advantage ariſing from the ſaltneſs of the waters of the ſea, much greater than what has been yet mentioned; which is, that their congelation is thus retarded.— Some, indeed, have gone ſo far as to ſay, that ſea-water never freezes[*]: but this is an aſſertion contradicted by experience. However, it is certain that it requires a much greater degree of cold to freeze it than freſh water; ſo that, while rivers and ſprings are ſeen converted into one ſolid body of ice, the ſea is always fit for navigation, and no way affected by the coldneſs of the ſevereſt winter. It is, therefore, one of the greateſt bleſſings we derive from this element, that, when at land all the ſtores of Nature are locked up from us, we find the ſea ever open to our neceſſities, and patient of the hand of induſtry.

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* Phil. Tranſ. vol. ii. p. 297.

But it muſt not be ſuppoſed, becauſe in our temperate climate we never ſee the ſea frozen, that it is in the ſame manner open in every part of it. A very little acquaintance with the accounts of mariners, muſt have informed us, that at the polar regions it is embarraſſed with mountains and moving ſheets of ice, that often render it impaſſable. Theſe tremendous floats are of different magnitudes; ſometimes riſing more than a thouſand feet above the ſurface of the water[†]; ſometimes diffuſed into plains of above two hundred leagues in length; and, in many parts, ſixty or eighty broad. They are uſually divided by fiſſures; one piece following another ſo cloſe, that a perſon may ſtep from one to the other.—Sometimes mountains are ſeen riſing amidſt theſe plains, and preſenting the appearance of a variegated landſcape, with hills and valleys, houſes, churches, and towers. Theſe are appearances in which all naturaliſts are agreed; but the great conteſt is reſpecting their formation. Mr. Buffon aſſerts[‡], that they are formed from freſh-water alone; which congealing at the mouths of great rivers, accumulate thoſe huge maſſes that diſturb navigation. However, this great naturaliſt ſeems not to have been aware that there are two ſorts of ice floating in theſe ſeas; the flat ice, and the mountain ice: the one formed of ſea-water only; the other of freſh[‖].

The flat or driving ice, is entirely compoſed of ſea-water; which, upon diſſolution, is found to be ſalt; and is readily diſtinguiſhed from the mountain or freſh-water ice by its whiteneſs, and want of tranſparency. This ice is much more terrible to mariners than that which riſes up in lumps: a ſhip can avoid the one, as it is ſeen at a diſtance; but it often gets in among the other, which, ſometimes cloſing, cruſhes it to pieces. This, which manifeſtly has a different origin from the freſh-water ice, may perhaps have been produced in the Icy Sea, beneath the pole; or along the coaſts of Spitzbergen, or Nova Zembla.

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[*] Macrobius.

[†] Crantz's Hiſtory of Greenland, vol. i. p. 31.

[‡] Buffon, vol. ii. p. 91.

[‖] Crantz.

The mountain-ice, as was ſaid, is different in every reſpect, being formed of freſh-water, and appearing hard and tranſparent; it is generally of a pale green colour, though ſome pieces are of a beautiful ſky-blue; many large maſſes, alſo, appear grey; and ſome black. If examined more nearly, they are found to be incorporated with earth, ſtones, and bruſh-wood waſhed from the ſhore. On theſe alſo, are ſometimes found, not only earth, but neſts with birds eggs, at ſeveral hundred miles from land. The generality of theſe, though almoſt totally freſh, have nevertheleſs, a thick cruſt of ſalt-water frozen upon them, probably from the power that ice has ſometimes to produce ice. Such mountains as are here deſcribed, are moſt uſually ſeen at ſpring-time, and after a violent ſtorm, driving out to ſea, where they at firſt terrify the mariner, and are ſoon after daſhed to pieces by the continual waſhing of the waves; or driven into the warmer regions of the ſouth, there to be melted away. They ſometimes, however, ſtrike back upon their native ſhores, where they ſeem to take root at the feet of the mountains; and, as Martius tells us, are ſometimes higher than the mountains themſelves. Thoſe ſeen by him, were blue, full of clefts and cavities made by the rain, and crowned with ſnow, which, alternately thawing and freezing every year augmented their ſize. Theſe, compoſed of materials more ſolid than that driving at ſea, preſented a variety of agreeable figures to the eye, that with a little help from fancy aſſumed the appearance of trees in bloſſom; the inſide of churches, with arches, pillars, and windows; and the blue-coloured rays, darting from within, preſented the reſemblance of a glory.

If we inquire into the origin and formation of theſe, which, as we ſee, are very different from the former, I think we have a very ſatisfactory account of them in Crantz's Hiſtory of Greenland; and I will take leave to give the paſſage, with a very few alterations. "Theſe mountains of ice," ſays he, "are not ſalt, like the ſea-water, but ſweet; and, therefore, can be formed no where except on the mountains, in rivers, in caverns, and againſt the hills near the ſea-ſhore. The mountains of Greenland are ſo high, that the ſnow which falls upon them, particularly on the north-ſide, is in one night's time, wholly converted into ice: they alſo contain clefts and cavities, where the ſun ſeldom or never injects his rays: beſides theſe are projections, or landing-places, on the declivities of the ſteepeſt hills, where the rain and ſnow-water lodge, and quickly congeal. When now the accumulated flakes of ſnow ſlide down, or fall with the rain from the eminences above, on theſe prominences; or, when here and there a mountain-ſpring comes rolling down to ſuch a lodging-place, where the ice has already ſeated itſelf, they all freeze, and add their tribute to it. This, by degrees, waxes to a body of ice, that can no more be overpowered by the ſun; and which, though it may indeed, at certain ſeaſons, diminiſh by a thaw, yet, upon the whole, through annual acquiſitions, it aſſumes an annual growth. Such a body of ice is often prominent far over the rocks. It does not melt on the upper ſurface, but underneath; and often cracks into many larger or ſmaller clefts, from whence the thawed water trickles out. By this, it becomes, at laſt ſo weak, that being overloaded with its own ponderous bulk, it breaks looſe, and tumbles down the rocks with a terrible craſh.—Where it happens to overhang a precipice on the ſhore, it plunges into the deep with a ſhock like thunder; and with ſuch an agitation of the water, as will overſet a boat at ſome diſtance, as many a poor Greenlander has fatally experienced." Thus are theſe amazing ice-mountains launched forth to ſea, and found floating in the waters round both the poles. It is theſe that have hindered mariners from diſcovering the extenſive countries that lie round the South Pole; and that probably block up the paſſage to China by the North.

I will conclude this chapter, with one effect more, produced by the ſaltneſs of the ſea; which is the luminous appearance of its waves in the night. All who have been ſpectators of a ſea by night, a little ruffled with winds, ſeldom fail of obſerving its fiery brightneſs. In ſome places it ſhines as far as the eye can reach*; at other times, only when the waves boom againſt the ſide of the veſſel, or the oar daſhes into the water. Some ſeas ſhine often; others more ſeldom; ſome, ever when particular winds blow; and others within a narrow compaſs; a long tract of light being ſeen along the ſurface, whilſt all the reſt is hid in total darkneſs. It is not eaſy to account for theſe extraordinary appearances: ſome have ſuppoſed that a number of luminous inſects produced the effect, and this is in reality ſometimes the caſe; in general, however, they have every reſemblance to that light produced by electricity; and, probably, ariſe from the agitation and daſhing of the ſaline particles of the fluid againſt each other. But the manner in which this is done, for we can produce nothing ſimilar, by any experiments hitherto made, remains for ſome happier accident to diſcover. Our progreſs in the knowledge of Nature is ſlow; and it is a mortifying conſideration, that we are hitherto more indebted for ſucceſs to chance than induſtry.

CHAP. XVI.

OF THE TIDES, MOTION, AND CURRENTS OF THE SEA; WITH THEIR EFFECTS.

It was ſaid in the former chapter, that the waters of the ſea were kept ſweet by their motion; without which they would ſoon putrefy, and ſpread univerſal infection. If we look for final cauſes, here, indeed, we have a great and an obvious one that preſents itſelf before us. Had the ſea been made without motion, and reſembling a pool of ſtagnant water, the nobler races of Animated Nature would ſhortly be at an end. Nothing would then be left alive but ſwarms of ill-formed creatures, with ſcarce more than vegetable life; and ſubſiſting by putrefaction. Were this extenſive bed of waters entirely quieſcent, millions of the ſmaller reptile kinds would there find a proper retreat to breed and multiply in; they would find there no agitation, no concuſſion in the parts of the fluid to cruſh their feeble frames, or to force them from the places where they were bred: there they would multiply in ſecurity and eaſe, enjoy a ſhort life, and, putrefying, thus again give nouriſhment to numberleſs others, as little worthy of exiſtence as themſelves. But the motion of this great element, effectually deſtroys the number of theſe viler creatures; its currents, and its tides produce continual agitations, the ſhock of which they are not able to endure; the parts of the fluid rubbing againſt each other, deſtroy all viſcidities; and the ocean, if I may ſo expreſs it, acquires health by exerciſe.

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* Boyle, vol. i. p. 294.

The moſt obvious motion of the ſea, and the moſt generally acknowledged, is that of its tides. This element is obſerved to flow for certain hours, from ſouth towards the north; in which motion or flux, which laſts about ſix hours, the ſea gradually ſwells; ſo that entering the mouths of rivers, it drives back the river-waters to their heads. After a continual flux of ſix hours, the ſea ſeems to reſt for a quarter of an hour; and then begins to ebb, or retire back again, from north to ſouth, for ſix hours more; in which time the waters ſinking, the rivers reſume their natural courſe. After a ſeeming pauſe of a quarter of an hour, the ſea again begins to flow as before: and thus it has alternately riſen and fallen, twice a-day, ſince the creation.

This amazing appearance did not fail to excite the curioſity, as it did the wonder of the ancients. After ſome wild conjectures of the earlieſt philoſophers, it became well known in the times of Pliny, that the tides were entirely under the influence, in a ſmall degree, of the ſun; but in a much greater of the moon. It was found that there was a flux and reflux of the ſea, in the ſpace of twelve hours fifty minutes, which is exactly the time of a lunar day. It was obſerved, that whenever the moon was in the meridian, or, in other words, as nearly as poſſible over any part of the ſea, that the ſea flowed to that part, and made a tide there; on the contrary, it was found, that when the moon left the meridian, the ſea began to flow back again from whence it came; and there might be ſaid to ebb. Thus far the waters of the ſea ſeemed very regularly to attend the motions of the moon. But as it appeared, likewiſe, that when the moon was in the oppoſite meridian, as far off on the other ſide of the globe, that there was a tide on this ſide alſo; ſo that the moon produced two tides, one by her greateſt approach to us, and another by her greateſt diſtance from us: in other words, the moon, in once going round the earth, produced two tides, always at the ſame time; one on the other part of the globe directly under her; and the other, on the part of the globe directly oppoſite.

Mankind continued for ſeveral ages content with knowing the general cauſe of theſe wonders, hopeleſs of diſcovering the particular manner of the moon's operation. Kepler was the firſt who conjectured that attraction was the principal cauſe, aſſerting, that the ſphere of the moon's operation extended to the earth, and drew up its waters. The preciſe manner in which this is done, was diſcovered by Newton.

The moon has been found, like all the reſt of the planets, to attract, and to be attracted by the earth. This attraction prevails throughout our whole planetary ſyſtem. The more matter there is contained in any body, the more it attracts; and its influence decreaſes in proportion as the diſtance, when ſquared, increaſes. This being premiſed, let us ſee what muſt enſue upon ſuppoſing the moon in the meridian of any tract of the ſea. The ſurface of the water immediately under the moon, is nearer the moon than any other part of the globe is; and, therefore, muſt be more ſubject to its attraction than the waters any where elſe. The waters will, therefore, be attracted by the moon, and riſe in a heap; whoſe eminence will be the higheſt where the attraction is greateſt. In order to form this eminence, it is obvious that the ſurface, as well as the depths, will be agitated; and that wherever the water runs from one part, ſucceeding waters muſt run to fill up the ſpace it has left. Thus the waters of the ſea, running from all parts, to attend the motions of the moon, produce the flowing of the tide; and it is high tide at that part wherever the moon comes over it, or to its meridian.

But when the moon travels onward, and ceaſes to point over the place where the waters were juſt riſen, the cauſe here of their riſing ceaſing to operate, they will flow back by their natural gravity into the lower parts from whence they had travelled; and this retiring of the waters will form the ebbing of the ſea.

Thus the firſt part of the demonſtration is obvious; ſince, in general, it requires no great ſagacity to conceive that the waters neareſt the moon are moſt attracted, or raiſed higheſt by the moon. But the other part of the demonſtration, namely, how there come to be high tides at the ſame time, on the oppoſite ſide of the globe, and where the waters are fartheſt from the moon, is not ſo eaſy to conceive. To comprehend this, it muſt be obſerved, that the part of the earth and its waters that are fartheſt from the moon, are the parts of all others that are leaſt attracted by the moon: it muſt alſo be obſerved, that all the waters, when the moon is on the oppoſite ſide of the earth, muſt be attracted by it in the ſame direction that the earth itſelf attracts them; that is, if I may ſo ſay, quite through the body of the earth, towards the moon itſelf. This, therefore, being conceived, it is plain that thoſe waters which are fartheſt from the moon, will have leſs weight than thoſe of any other part, on the ſame ſide of the globe; becauſe the moon's attraction, which conſpires with the earth's attraction, is there leaſt. Now, therefore, the waters fartheſt from the moon, having leſs weight, and being lighteſt, will be preſſed on all ſides, by thoſe that, having more attraction, are heavier: they will be preſſed, I ſay, on all ſides; and the heavier waters flowing in, will make them ſwell and riſe, in an eminence directly oppoſite to that on the other ſide of the globe, cauſed by the more immediate influence of the moon.

In this manner, the moon, in one diurnal revolution, produces two tides; one raiſed immediately under the ſphere of its influence, and the other directly oppoſite to it. As the moon travels, this vaſt body of waters rears upward, as if to watch its motions; and purſues the ſame conſtant rotation. However, in this great work of raiſing the tides, the ſun has no ſmall ſhare; it produces its own tides conſtantly every day, juſt as the moon does, but in a much leſs degree, becauſe the ſun is at an immenſely greater diſtance. Thus there are ſolar tides, and lunar tides. When the forces of theſe two great luminaries concur, which they always do when they are either in the ſame, or in oppoſite parts of the the heavens, they jointly produce a much greater tide, than when they are ſo ſituated in the heavens, as each to make peculiar tides of their own. To expreſs the very ſame thing technically; in the conjunctions and oppoſitions of the ſun and moon, the attraction of the ſun conſpires with the attraction of the moon; by which means the high ſpring-tides are formed. But in the quadratures of the ſun and moon, the water raiſed by the one is depreſſed by the other; and hence the lower neap-tides have their production. In a word, the tides are greateſt in the ſyzigies, and leaſt in the quadratures.

This theory well underſtood, and the aſtronomical terms previouſly known, it may readily be brought to explain the various appearances of the tides, if the earth were covered with a deep ſea, and the waters uninfluenced by ſhoals, currents, ſtraits, or tempeſts. But in every part of the ſea, near the ſhores, the geographer muſt come in to correct the calculations of the aſtronomer. For, by reaſon of the ſhallowneſs of ſome places, and the narrowneſs of the ſtraits in others, there ariſes a great diverſity in the effect, not to be accounted for without an exact knowledge of all the circumſtances of the place. In the great depths of the ocean, for inſtance, a very ſlow and imperceptible motion of the whole body of water will ſuffice to raiſe its ſurface ſeveral feet high; but if the ſame increaſe of water is to be conveyed through a narrow channel, it muſt ruſh through it with the moſt impetuous rapidity. Thus, in the Engliſh Channel, and the German Ocean, the tide is found to flow ſtrongeſt in thoſe places that are narroweſt; the ſame quantity of water being, in this caſe, driven through a ſmaller paſſage. It is often ſeen, therefore, pouring through a ſtrait with great force; and by its rapidity, conſiderably raiſed above the ſurface of that part of the ocean into which it runs.

This ſhallowneſs and narrowneſs in many parts of the ſea, give alſo riſe to a peculiarity in the tides of ſome parts of the world. For in many places, and in our own ſeas in particular, the greateſt ſwell of the tide is not while the moon is in its meridian height, and directly over the place, but ſome time after it has declined from thence. The ſea, in this caſe, being obſtructed, purſues the moon with what deſpatch it can, but does not arrive with all its waters till long after the moon has ceaſed to operate. Laſtly, from this ſhallowneſs of the ſea, and from its being obſtructed by ſhoals and ſtraits, we may account for the Mediterranean, the Baltic, and the Black Sea, having no ſenſible tides. Theſe, though to us they ſeem very extenſive, are not however large enough to be affected by the influence of the moon; and as to their communication with the ocean, through ſuch narrow inlets, it is impoſſible in a few hours time that they ſhould receive and return water enough to raiſe or depreſs them in any conſiderable degree.

In general, therefore, we may obſerve, that all tides are much higher, and more conſiderable in the torrid zone, than in the reſt of the ocean; the ſea in thoſe parts being generally deeper, and leſs affected by changeable winds, or winding ſhores*. The greateſt tide we know of, is that at the mouth of the river Indus, where the water riſes thirty feet in height. How great, therefore, muſt have been the amazement of Alexander's ſoldiers at ſo ſtrange an appearance! They who always before had been accuſtomed only to the ſcarcely perceptible riſings of the Mediterranean, or the minute intumeſcence of the Black Sea, when made at once ſpectators of a river riſing and falling thirty feet in a few hours, muſt no doubt have felt the moſt extreme awe, and, as we are told†, a mixture of curioſity and apprehenſion. The tides are alſo remarkably high on the coaſts of Malay, in the ſtraits of Sunda, in the Red Sea, at the mouth of the river St. Lawrence, along the coaſts of China and Japan, at Panama, and in the gulph of Bengal. The tides at Tonquin, however, are the moſt remarkable in the world. In this part there is but one tide, and one ebb, in twenty-four hours; whereas, as we have ſaid before, in other places there are two. Beſides, there, twice in each month, there is no tide at all, when the moon is near the equinoctial, the water being for ſome time quite ſtagnant. Theſe, with ſome other odd appearances attending the ſame phænomena, were conſidered by many as inſcrutable; but Sir Iſaac Newton, with peculiar ſagacity, adjudged them to ariſe from the concurrence of two tides, one from the South Sea, and the other from the Indian Ocean. Of each of theſe tides there come ſucceſſively two every day; two at one time greater, and two at another that are leſs. The time between the arrival of the two greater, is conſidered by him as high tide; the time between the two leſſer, as ebb. In ſhort, with this clue, that great mathematician ſolved every appearance, and ſo eſtabliſhed his theory as to ſilence every oppoſer.

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* Buffon, vol. ii. p. 187.

† Quintus Curtius.

This fluctuation of the ſea from the tides, produces another, and more conſtant rotation of its waters, from the eaſt to the weſt, in this reſpect following the courſe of the moon. This may be conſidered as one great and general current of the waters of the ſea; aud although it be not every where diſtinguiſhable, it is nevertheleſs every where exiſtent, except when oppoſed by ſome particular current or eddy, produced by partial and local cauſes. This tendency of the ſea towards the weſt, is plainly perceivable in all the great ſtraits of the ocean; as, for inſtance, in thoſe of Magellan, where the tide running in from the eaſt, riſes twenty feet high, and continues flowing ſix hours; whereas the ebb continues but two hours, and the current is directed to the weſt. This proves that the flux is not equal to the reflux; and that from both reſults a motion of the ſea weſtward, which is more powerful during the time of the flux than the reflux.

But this motion weſtward has been ſenſibly obſerved by navigators, in their paſſage back from India to Madagaſcar, and ſo on to Africa. In the great Pacific Ocean alſo, it is very perceivable: but the places where it is moſt obvious are, as was ſaid, in thoſe ſtraits which join one ocean to another. In the ſtraits between the Maldivia iſlands, in the gulph of Mexico, between Cuba and Jucatan. In the ſtraits of the gulph of Paria, the motion is ſo violent that it hath received the appellation of the Dragon's Mouth. Northward, in the ſea of Canada, in Waigat's ſtraits, in the ſtraits of Java, and, in ſhort, in every ſtrait where the ocean on one part pours into the ocean on the other. In this manner, therefore, is the ſea carried with an unceaſing circulation round the globe; and, at the ſame time that its waters are puſhed back and forward with the tide, they have thus a progreſſive current to the weſt, which though leſs obſervable, is not the leſs real.

Beſides theſe two general motions of the ſea, there are others which are particular to many parts of it, and are called *currents*. Theſe are found to run in all directions, eaſt, weſt, north, and ſouth; being formed, as was ſaid above, by various cauſes; the prominence of the ſhores, the narrowneſs of the ſtraits, the variations of the wind, and the inequalities at the bottom. Theſe, though no great object to the philoſopher, as their cauſes are generally local and obvious, are nevertheleſs of the moſt material conſequence to the mariner; and, without a knowledge of which, he could never ſucceed. It often has happened, that when a ſhip has unknowingly got into one of theſe, every thing ſeems to go forward with ſucceſs, the mariners ſuppoſe themſelves every hour approaching their wiſhed-for port, the wind fills their ſails, and the ſhip's prow ſeems to divide the water; but, at laſt, by miſerable experience they find, that inſtead of going forward, they have been all the time receding. The buſineſs of currents, therefore, makes a conſiderable article in navigation; and the direction of their ſtream, and their rapidity, has been carefully ſet down. This ſome do by the obſervation of the ſurface, of the current; or by the driving of the froth along the ſhore; or by throwing out what is called the *log-line*, with a buoy made for that purpoſe, and by the direction and motion of this, they judge of the ſetting, and the rapidity of the current.

Theſe currents are generally found to be moſt violent under the equator, where indeed all the motions of the ocean are moſt perceiveable. Along the coaſts of Guinea, if a ſhip happens to overſhoot the mouth of any river it is bound to, the current prevents its return; ſo that it is obliged to ſteer out to ſea, and take a very large compaſs, in order to correct the former miſtake. Theſe ſet in a contrary direction to the general motion of the ſea weſtward; and that ſo ſtrongly, that a paſſage which, with the current, is made in two days, is with difficulty performed in ſix weeks againſt it. However, they do not extend above twenty leagues from the coaſt; and ſhips going to the Eaſt-Indies, take care not to come within the ſphere of their action. At Sumatra, the currents, which are extremely rapid, run from ſouth to north: there are alſo ſtrong currents between Madagaſcar and the Cape of Good Hope. On the weſtern coaſts of America, the current always runs from the ſouth to the north, where a ſouth wind, continually blowing, moſt probably occaſions this phænomenon. But the currents that are moſt remarkable, are thoſe continually flowing in the Mediterranean ſea, both from the ocean by the ſtraits of Gibraltar, and at its other extremity, from the Euxine ſea by the Archipelago. This is one of the moſt extraordinary appearances in Nature, this large ſea receiving not only the numerous rivers that fall into it, ſuch as the Nile, the Rhone, and the Po, but alſo a very great influx from the Euxine ſea on one part, and the ocean on the other. At the ſame time, it is ſeen to return none of thoſe waters it is thus known to receive: Outlets running from it there are none; no rivers but ſuch as bring it freſh ſupplies; no ſtraits but what are conſtantly pouring their waters into it: it has, therefore, been the wonder of mankind in every age, how, and by what means this vaſt concourſe of waters are diſpoſed of; or how this ſea, which is always receiving, and never returning, is no way fuller than before. In order to account for this, ſome have ſaid, that the water was re-conveyed by ſubterraneous paſſages into the Red Sea*. There is a ſtory told of an Arabian califf, who caught a dolphin in this ſea, admiring the beauty of which, he let it go again, having previouſly marked it by a ring of iron. Some time after a dolphin was caught in the Red Sea, and quickly known by the ring to be the ſame that had been taken in the Mediterranean before. Such, however, as have not been willing to found their opinions upon a ſtory, have attempted to account for the diſpoſal of the waters of the Mediterranean by evaporation. For this purpoſe they have entered into long calculations upon the extent of its ſurface, and the quantity of water that would be raiſed from ſuch a ſurface in a year. They then compute how much water runs in by its rivers and ſtraits in that time; and find, that the quantity exhauſted by evaporation, greatly exceeds the quantity ſupplied by rivers and ſeas. This ſolution, no doubt would be ſatisfactory, did not the ocean, and the Euxine, evaporate as well as the Mediterranean: and as theſe are ſubject to the ſame drain, it muſt follow, that all the ſeas will in this reſpect be upon a par; and, therefore, there muſt be ſome other cauſe for this unperceived drain, and continual ſupply. This ſeems to be ſatisfactorily enough accounted for by Dr. Smith, who ſuppoſes an under current running through the ſtraits of Gibraltar to carry out as much water into the ocean, as the upper current continually carries in from it. To confirm this, he obſerves, that nearer home, between the north and the ſouth foreland, the tide is known to run one way at top, and the ebb another way at bottom. This double current he alſo confirms by an experiment communicated to him by an able ſeaman, who being with one of the king's frigates in the Baltic, found he went with his boat into the mid-ſtream, and was carried violently by the current; upon which a baſket was ſunk, with a large cannon-ball, to a certain depth of water, which gave a check to the boat's motion; as the baſket ſunk ſtill lower, the boat was driven, by the force of the water below, againſt the upper current; and the lower the baſket was let down, the ſtronger the under current was found, and the quicker was the boat's motion againſt the upper ſtream, which ſeemed not to be above four fathom deep. From hence we may readily infer, that the ſame cauſe may operate at the ſtraits of Gibraltar; and that while the Mediterranean ſeems repleniſhing at top, it may be emptying at bottom.

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* Kircher Mund. Subt. vol. i.

The number of the currents at ſea are impoſſible to be recounted, nor indeed are they always known; new ones are daily produced by a variety of cauſes, and as quickly diſappear. When a regular current is oppoſed by another in a narrow ſtrait, or where the bottom of the ſea is very uneven, a whirlpool is often formed. Theſe were formerly conſidered as the moſt formidable obſtructions to navigation; and the ancient poets and hiſtorians ſpeak of them with terror; they are deſcribed as ſwallowing up ſhips, and daſhing them againſt the rocks at the bottom: apprehenſion did not fail to add imaginary terrors to the deſcription, and placed at the centre of the whirlpool a dreadful den, fraught with monſters whoſe howlings ſerved to add new horrors to the daſhings of the deep. Mankind at preſent, however, view theſe eddies of the ſea with very little apprehenſion; and ſome have wondered how the ancients could have ſo much overcharged their deſcriptions. But all this is very naturally accounted for. In thoſe times when navigation was in its infancy, and the ſlighteſt concuſſion of the waves generally ſent the poor adventurer to the bottom, it is not to be wondered at that he was terrified at the violent agitations in one of theſe. When his little ſhip, but ill fitted for oppoſing the fury of the ſea, was got within the vortex, there was then no poſſibility of ever returning. To add to the fatality, they were always near the ſhore; and along the ſhore was the only place where this ill-provided mariner durſt venture to ſail. Theſe were, therefore, dreadful impediments to his navigation; for if he attempted to paſs between them and the ſhore, he was ſometimes ſucked in by the eddy; and if he attempted to avoid them out at ſea, he was often ſunk by the ſtorm. But in our time, and in our preſent improved ſtate of navigation, Charybdis, and the Euripus, with all the other irregular currents of the Mediterranean, are no longer formidable. Mr. Addiſon not attending to this train of thinking, upon paſſing through the ſtraits of Sicily, was ſurpriſed at the little there was of terror in the preſent appearance of Sylla and Charybdis; and ſeems to be of opinion, that their agitations are much diminiſhed ſince the times of antiquity. In fact, from the reaſons above, all the wonders of the Mediterranean ſea are deſcribed in much higher colours than they merit, to us who are acquainted with the more magnificent terrors of the ocean. The Mediterranean is one of the ſmootheſt and moſt gentle ſeas in the world: its tides are ſcarce perceivable, except in the gulph of Venice, and ſhipwrecks are leſs known there than in any other part of the world.

It is in the ocean, therefore, that theſe whirlpools are particularly dangerous, where the tides are violent, and the tempeſts fierce. To mention only one, that called *the Maelſtroom*, upon the coaſts of Norway, which is conſidered as the moſt dreadful and voracious in the world. The name it has received from the natives, ſignifies *the navel of the ſea;* ſince they ſuppoſe that a great ſhare of the water of the ſea is ſucked up and diſcharged by its vortex. A minute deſcription of the internal parts is not to be expected, ſince none who were there ever returned to bring back information. The body of the waters that form this whirlpool, are extended in a circle above thirteen miles in circumference*. In the midſt of this ſtands a rock, againſt which the tide in its ebb is daſhed with inconceivable fury. At this time it inſtantly ſwallows up all things that come within the ſphere of its violence, trees, timber, and ſhipping. No ſkill in the mariner, nor ſtrength of rowing, can work an eſcape: the ſailor at the helm finds the ſhip at firſt go in a current oppoſite to his intentions; his veſſel's motion, though ſlow in the beginning, becomes every moment more rapid; it grows round in circles ſtill narrower and narrower, till at laſt it is daſhed againſt the rocks, and inſtantly diſappears: nor is it ſeen again for ſix hours; till the tide flowing, it is vomited forth with the ſame violence with which it was drawn in. The noiſe of this dreadful vortex ſtill farther contributes to increaſe its terror, which, with the daſhing of the waters, and the dreadful valley, if it may be ſo called, cauſed by their circulation, makes one of the moſt tremendous objects in Nature.

CHAP. XVII.

OF THE CHANGES PRODUCED BY THE SEA UPON THE EARTH.

FROM what has been ſaid, as well of the earth as of the ſea, they both appear to be in continual fluctuation. The earth, the common promptuary that ſupplies ſubſiſtence to men, animals, and vegetables, is continually furniſhing its ſtores to their ſupport. But the matter which is thus derived from it, is ſoon reſtored and laid down again to be prepared for freſh mutations. The tranſmigration of ſouls is no doubt falſe and whimſical; but nothing can be more certain than the tranſmigration of bodies: the ſpoils of the meaneſt reptile may go to the formation of a prince; and, on the contrary, as the poet has it, the body of Cæſar may be employed in ſtopping a beer-barrel. From this, and other cauſes, therefore, the earth is in continual change. Its internal fires, the deviation of its rivers, and the falling of its mountains, are daily altering its ſurface; and geography can ſcarce recollect the lakes and the vallies that hiſtory once deſcribed.

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* Kircher Mund. Sub. vol. i. p. 156.

But theſe changes are nothing to the inſtability of the ocean. It would ſeem that inquietude was as natural to it as its fluidity. It is firſt ſeen with a conſtant and equable motion going towards the weſt; the tides then interrupt this progreſſion, and for a time drive the waters in a contrary direction; beſides theſe agitations, the currents act their part in a ſmaller ſphere, being generally greateſt where the other motions of the ſea are leaſt; namely, neareſt the ſhore: the winds alſo contribute their ſhare in this univerſal fluctuation; ſo that ſcarce any part of the ſea is wholly ſeen to ſtagnate.

Nil enim quieſcit, undis impellitur unda,
Et ſpiritus et calor toto ſe corpore miſcent.

As this great element is thus changed, and continually labouring internally, it may be readily ſuppoſed that it produces correſpondent changes upon its ſhores, and thoſe parts of the earth ſubject to its influence. In fact it is every day making conſiderable alterations, either by overflowing its ſhores in one place, or deſerting them in others; by covering over whole tracts of country that were cultivated and peopled, at one time; or by leaving its bed to be appropriated to the purpoſes of vegetation, and to ſupply a new theatre for human induſtry at another.

In this ſtruggle between the earth and the ſea for dominion, the greateſt number of our ſhores ſeem to defy the whole rage of the waves, both by their height, and the rocky materials of which they are compoſed. The coaſts of Italy, for inſtance*, are bordered with rocks of marble of different kinds, the quarries of which may eaſily be diſtinguiſhed at a diſtance from ſea, and appear like perpendicular columns of the moſt beautiful kinds of marble, ranged along the ſhore. In general, the coaſts of France, from Breſt to Bourdeaux, are compoſed of rocks; as are alſo thoſe of Spain and England, which defend the land, and only are interrupted, here and there to give an egreſs to rivers, and to grant the conveniences of bays and harbours to our ſhipping. It may be in general remarked, that wherever the ſea is moſt violent and furious, there the boldeſt ſhores, and of the moſt compact materials, are found to oppoſe it. There are many ſhores ſeveral hundred feet perpendicular, againſt which the ſea, when ſwollen with tides or ſtorms, riſes and beats with inconceivable fury. In the Orkneys*, where the ſhores are thus formed, it ſometimes, when agitated by a ſtorm, riſes two hundred feet perpendicular, and daſhes up its ſpray, together with ſand and other ſubſtances that compoſe its bottom, upon land, like ſhowers of rain.

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* Buffon, vol. ii. p. 199.

From hence, therefore, we may conceive how the violence of the ſea, and the boldneſs of the ſhore, may be ſaid to have made each other. Where the ſea meets no obſtacles, it ſpreads its waters with a gentle intumeſcence, till all its power is deſtroyed, by wanting depth to aid the motion. But when its progreſs is checked in the midſt, by the prominence of rocks, or the abrupt elevation of the land, it daſhes with all the force of its depth againſt the obſtacle, and forms, by its repeated violence, that abruptneſs of the ſhore which confines its impetuoſity. Where the ſea is extremely deep, or very much vexed by tempeſts, it is no ſmall obſtacle that can confine its rage; and for this reaſon we ſee the boldeſt ſhores projected againſt the deepeſt waters; all leſs impediments having long before been ſurmounted and waſhed away. Perhaps of all the ſhores in the world, there is not one ſo high as that on the weſt of St. Kilda, which, upon a late admeaſurement†, was found to be ſix hundred fathom perpendicular above the ſurface of the ſea. Here alſo, the ſea is deep, turbulent, and ſtormy; ſo that it requires great force in the ſhore to oppoſe its violence. In many parts of the world, and particularly upon the coaſts of the Eaſt Indies, the ſhores, though not high above water, are generally very deep, and conſequently the waves roll againſt the land, with great weight and irregularity. This riſing of the waves againſt the ſhore, is called by mariners *the ſurf of the ſea;* and in ſhipwrecks is generally fatal to ſuch as attempt to ſwim on ſhore. In this caſe no dexterity in the ſwimmer, no float he can uſe, neither ſwimming-girdle nor cork-jacket will ſave him; the weight of the ſuperincumbent waves break upon him at once, and cruſhes him with certain ruin. Some few of the natives, however, have the art of ſwimming and navigating their little boats near thoſe ſhores where an European is ſure of inſtant deſtruction.

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* Buffon, vol. ii. p. 191.

† Deſcription of St. Kilda.

In places where the force of the ſea is leſs violent, or its tides leſs rapid, the ſhores are generally ſeen to deſcend with a more gradual declivity. Over theſe, the waters of the tide ſteal by almoſt imperceptible degrees, covering them for a large extent, and leaving them bare on its receſs. Upon theſe ſhores, as was ſaid, the ſea ſeldom beats with any great violence, as a large wave has not depth ſufficient to float it onwards, ſo that here only are to be ſeen gentle ſurges making calmly towards land, and leſſening as they approach. As the ſea, in the former deſcription, is generally ſeen to preſent proſpects of tumult and uproar, here it more uſually exhibits a ſcene of repoſe and tranquil beauty. Its waters which, when ſurveyed from the precipice, afforded a muddy greeniſh hue, ariſing from their depth and poſition to the eye*, when regarded from the ſhelving ſhore wear the colour of the ſky, and ſeem riſing to meet it. The deafening noiſe of the deep ſea, is here converted into gentle murmurs; inſtead of the water daſhing againſt the face of the rock, it advances and recedes, ſtill going forward, but with juſt force enough to puſh its weeds and ſhells, by inſenſible approaches to the ſhore.

There are other ſhores, beſides thoſe already deſcribed, which either have been raiſed by Art, to oppoſe the ſea's approaches, or, from the ſea's gaining ground, are threatened with imminent deſtruction. The ſea's being thus ſeen to give and take away lands at pleaſure, is, without queſtion, one of the moſt extraordinary conſiderations in all natural hiſtory. In ſome places it is ſeen to obtain the ſuperiority by ſlow and certain approaches; or to burſt in at once, and overwhelm all things in undiſtinguiſhed deſtruction; in other places it departs from its ſhores, and where its waters have been known to rage, it leaves fields covered with the moſt beautiful verdure.

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* Newton's Optics, p. 163, 167.

The formation of new lands by the ſea's continually bringing its ſediment to one place, and by the accumulation of its ſands in another, is eaſily conceived. We have had many inſtances of this in England. The iſland of Oxney, which is adjacent to Romney-marſh, was produced in this manner. This had for a long time been a low level, continually in danger of being overflown by the river Rother; but the ſea, by its depoſitions, has gradually raiſed the bottom of the river, while it has hollowed the mouth; ſo that the one is ſufficiently ſecured from inundations, and the other is deep enough to admit ſhips of conſiderable burden. The like alſo may be ſeen at that bank called the *Dogger-ſands*, where two tides meet, and which thus receive new increaſe every day, ſo that in time the place ſeems to promiſe fair for being habitable earth. On many parts of the coaſts of France, England, Holland, Germany, and Pruſſia, the ſea has been ſenſibly known to retire*. Hubert Thomas aſſerts, in his Deſcription of the Country of Liege, that the ſea formerly encompaſſed the city of Tongres, which, however, is at preſent thirty-five leagues diſtant from it: this aſſertion he ſupports by many ſtrong reaſons; and among others, by the iron rings fixed in the walls of the town, for faſtening the ſhips that came into the port. In Italy there is a conſiderable piece of ground gained at the mouth of the river Arno; and Ravenna, that once ſtood by the ſea-ſide, is now conſiderably removed from it. But we need ſcarce mention theſe, when we find that the whole republic of Holland ſeems to be a conqueſt upon the ſea, and, in a manner, reſcued from its boſom. The ſurface of the earth, in this country, is below the level of the bed of the ſea; and I remember, upon approaching the coaſt, to have looked down upon it from the ſea, as into a valley; however it is every day riſing higher by the depoſitions made upon it by the ſea, the Rhine, and the Meuſe; and thoſe parts which formerly admitted large men of war, are now known to be too ſhallow to receive ſhips of very moderate burthen* The province of Jucatan, a peninſula in the Gulph of Mexico, was formerly a part of the ſea: This tract which, ſtretches out into the ocean a hundred leagues, and which is above thirty broad, is every where, at a moderate depth below the ſurface, compoſed of ſhells, which evince that its land once formed the bed of the ſea. In France, the town of Aigues Mortes was a port in the time of St. Louis, which is now removed more than four miles from the ſea. Pſalmodi, in the ſame kingdom, was an iſland in the year 815, but is now more than ſix miles from the ſhore. All along the coaſts of Norfolk, I am very well aſſured, that in the memory of man, the ſea has gained fifty yards in ſome places, and loſt as much in others.

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* Buffon, vol. vi. p. 424.

Thus numerous, therefore, are the inſtances of new lands having been produced from the ſea, which, as we ſee, is brought about two different ways: firſt, by the waters raiſing banks of ſand and mud where their ſediment is depoſited; and, ſecondly, by their relinquiſhing the ſhore entirely, and leaving it unoccupied to the induſtry of man.

But as the ſea has been thus known to recede from ſome lands, ſo has it, by fatal experience, been found to encroach upon others; and, probably, theſe depredations on one part of the ſhore, may account for their dereliction from another; for the current which reſted upon ſome certain bank, having got an egreſs in ſome other place, it no longer preſſes upon its former bed, but pours all its ſtream into the new entrance; ſo that every inundation of the ſea may be attended with ſome correſpondent dereliction of another ſhore.

However this be, we have numerous hiſtories of the ſea's inundations, and its burying whole provinces in its boſom. Many countries that have been thus deſtroyed, bear melancholy witneſs to the truth of hiſtory; and ſhew the tops of their houſes, and the ſpires of their ſteeples, ſtill ſtanding at the bottom of the water. One of the moſt conſiderable inundations we have in hiſtory, is that which happened in the reign of Henry I. which overflowed the eſtates of the Earl Godwin, and forms now that bank called the Goodwin Sands. In the year 1546, a ſimilar eruption of the ſea deſtroyed a hundred thouſand perſons in the territory of Dort; and yet a greater number round Dullart. In Friezland, and Zealand, there were more than three hundred villages overwhelmed; and their ruins continue ſtill viſible at the bottom of the water in a clear day. The Baltic ſea has, by ſlow degrees, covered a large part of Pomerania; and, among others, deſtroyed and overwhelmed the famous port of Vineta. In the ſame manner, the Norwegian ſea has formed ſeveral little iſlands from the main land, and ſtill daily advances upon the continent. The German ſea has advanced upon the ſhores of Holland, near Catt; ſo that the ruins of an ancient citadel of the Romans, which was formerly built upon this coaſt, are now actually under water. To theſe accidents ſeveral more might be added; our own hiſtorians, and thoſe of other countries, abound with them; almoſt every flat ſhore of any extent, being able to ſhew ſomething that it has loſt, or ſomething that it has gained from the ſea.

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* Buffon, vol. vi. 424.

There are ſome ſhores on which the ſea has made temporary depredations; where it has overflowed, and after remaining perhaps ſome ages, it has again retired of its own accord, or been driven back by the induſtry of man*. There are many lands in Norway, Scotland, and the Maldivia Iſlands, that are at one time covered with water, and at another free. The country round the iſle of Ely, in the time of Bede, about a thouſand years ago, was one of the moſt delightful ſpots in the whole kingdom; it was not only richly cultivated, and produced all the neceſſaries of life, but grapes alſo, that afforded excellent wine. The accounts of that time are copious in the deſcription of its verdure and fertility; its rich paſtures covered with flowers and herbage; its beautiful ſhades, and wholeſome air. But the ſea, breaking in upon the land, overwhelmed the whole country, took poſſeſſion of the ſoil, and totally deſtroyed one of the moſt fertile vallies in the world. Its air, from being dry and healthful, from that time became moſt unwholeſome, and clogged with vapours; and the ſmall part of the country that, by being higher than the reſt, eſcaped the deluge, was ſoon rendered uninhabitable, from its noxious vapours. Thus this country continued under water for ſome centuries; till, at laſt the ſea, by the ſame caprice which had prompted its invaſions, began to abandon the earth in like manner. It has continued for ſome ages to relinquiſh its former conqueſts; and although the inhabitants can neither boaſt the longevity, nor the luxuries of their former pre-occupants, yet they find ample means of ſubſiſtence; and if they happen to ſurvive the firſt years of their reſidence there, they are often known to arrive at a good old age.

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* Buffon, vol. ii. p. 425.

But although hiſtory be ſilent as to many other inundations of the like kind, where the ſea has overflowed the country, and afterwards retired, yet we have numberleſs teſtimonies of another nature, that prove it beyond the poſſibility of doubt: I mean thoſe numerous trees that are found buried at conſiderable depths in places where either rivers, or the ſea, has accidentally overflown*. At the mouth of the river Neſs, near Bruges, in Flanders, at the depth of fifty feet, are found great quantities of trees lying as cloſe to each other as they do in a wood: the trunks, the branches, and the leaves, are in ſuch perfect preſervation, that the particular kind of each tree may inſtantly be known. About five hundred years ago, this very ground was known to have been covered with the ſea; nor is there any hiſtory or tradition of its having been dry ground, which we can have no doubt muſt have been the caſe. Thus we ſee a country flouriſhing in verdure, producing large foreſts, and trees of various kinds, overwhelmed by the ſea. We ſee this element depoſiting its ſediment to an height of fifty feet; and its waters muſt, therefore, have riſen much higher. We ſee the ſame, after it has thus overwhelmed, and ſunk the land ſo deep beneath its ſlime, capriciouſly retiring from the ſame coaſts, and leaving that habitable once more, which it had formerly deſtroyed. All this is wonderful; and perhaps, inſtead of attempting to inquire after the cauſe, which has hitherto been inſcrutable, it will beſt become us to reſt ſatisfied with admiration.]

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* Buffon, vol. ii. p. 403.

At the city of Modena in Italy, and about four miles round it, wherever it is dug, when the workmen arrive at the depth of ſixty-three feet, they come to a bed of chalk, which they bore with an augre five feet deep: they then withdraw from the pit, before the augre is removed, and upon its extraction, the water burſts up through the aperture with great violence, and quickly fills this new-made well, which continues full, and is affected neither by rains nor droughts. But that which is moſt remarkable in this operation, is the layers of earth as we deſcend. At the depth of fourteen feet, are found the ruins of an ancient city, paved ſtreets, houſes, floors, and different pieces of Moſaic. Under this is found a ſolid earth, that would induce one to think had never been removed; however, under it is found a ſoft oozy earth, made up of vegetables; and at twenty-ſix feet depth, large trees entire, ſuch as watnut-trees, with the walnuts ſtill ſticking on the ſtem, and their leaves and branches in exact preſervation. At twenty-eight feet deep, a ſoft chalk is found, mixed with a vaſt quantity of ſhells; and this bed is eleven feet thick. Under this, vegetables are found again, with leaves, and branches of trees as before; and thus alternately chalk and vegetable earth to the depth of ſixty-three feet. Theſe are the layers wherever the workmen attempt to bore; while in many of them they alſo find pieces of charcoal, bones, and bits of iron. From this deſcription, therefore it appears, that this country has been alternately overflowed and deſerted by the ſea, one age after another: nor were theſe overflowings and retirings of trifling depth, or of ſhort continuance. When the ſea burſt in, it muſt have been a long time in overwhelming the branches of the fallen foreſt with its ſediment; and ſtill longer in froming a regular bed of ſhells eleven feet over them. It muſt have, therefore, taken an age, at leaſt, to make any one of theſe layers; and we may conclude, that it muſt have been many ages employed in the production of them all. The land alſo, upon being deſerted, muſt have had time to grow compact, to gather freſh fertility, and to be drained of its waters before it could be diſpoſed to vegetation, or before its trees could have ſhot forth again to maturity.

We have inſtances nearer home of the ſame kind given us in the Philoſophical Tranſactions; one of them by Mr. Derham. An inundation of the ſea, at Degenham, in Eſſex; laying bare a part of the adjacent paſture for above two hundred feet wide, and, in ſome places, twenty deep, it diſcovered a number of trees that had lain there for many ages before; theſe trees, by lying long under ground, were become black and hard, and their fibres ſo tough, that one might as eaſily break a wire, as any of them: they lay ſo thick in the place where they were found, that in many parts he could ſtep from one to another: he conceived alſo, that not only all the adjacent marſhes, for ſeveral hundred acres, were covered underneath with ſuch timber, but alſo the marſhes along the mouth of the Thames, for ſeveral miles. The meeting with theſe trees at ſuch depths, he aſcribes to the ſediment of the river, and the tides, which conſtantly waſhing over them, have always left ſome part of their ſubſtance behind, ſo as, by repeated alluvions, to work a bed of vegetable earth over them, to the height at which he found it.

The levels of Hatfield-Chace, in Yorkſhire, a tract of above eighteen thouſand acres, which was yearly overflown, was reduced to arable and paſture-land, by one Sir Cornelius Vermuſden, a Dutchman. At the bottom of this wide extent, are found millions of the roots and bodies of trees, of ſuch as this iſland either formerly did, or does at preſent produce. The roots of all ſtand in their proper poſtures; and by them, as thick as ever they could grow, the reſpective trunks of each, ſome above thirty yards long. The oaks, ſome of which have been ſold for fifteen pounds a piece, are as black as ebony, very laſting, and cloſe grained. The aſh-tre es are as ſoft as earth, and are commonly cut in pieces by the workmen's ſpades, and as ſoon as flung up into the open air, turn to duſt. But all the reſt, even the willows themſelves, which are ſofter than the aſh, preſerve their ſubſtance and texture to this very day. Some of the firs appear to have vegatated, even after they were fallen, and to have, from their branches, ſtruck up large trees, as great as the parent trunk. It is obſervable, that many of theſe trees have been burnt, ſome quite through, ſome on one ſide, ſome have been found chopped and ſquared, others riven with great wooden wedges, all ſufficiently manifeſting, that the country which was deluged, had formerly been inhabited. Near a great root of one tree, were found eight coins of the Roman emperors; and, in ſome places, the marks of the ridge and furrow were plainly perceivable, which teſtified that the ground had formerly been patient of cultivation.

The learned naturaliſt who has given this deſcription*, has pretty plainly evinced, that this foreſt, in particular, muſt have been thus levelled by the Romans; and that the falling of the trees, muſt have contributed to the accumulation of the waters. "The Romans," ſays he, "when the Britons fled, always purſued them into the fortreſſes of low woods, and miry foreſts: in theſe, the wild natives found ſhelter; and, when opportunity offered, iſſued out, and fell upon their invaders without mercy. In this manner, the Romans were at length ſo haraſſed, that orders were iſſued out for cutting down all the woods and foreſts in Britain. In order to effect this, and deſtroy the enemy the eaſier, they ſet fire to the woods, compoſed of pines, and other inflammable timber, which ſpreading, the conflagration deſtroyed not only the foreſt, but infinite numbers of the wretched inhabitants who had taken ſhelter therein. When the pine-trees had thus done what miſchief they could, the Romans then brought their army nearer, and, with whole legions of the captive Britons, cut down moſt of the trees that were yet left ſtanding; leaving only here and there ſome trees untouched, as monuments of their fury. Theſe, unneedful of their labour, being deſtitute of the ſupport of the underwood, and of their neighbouring trees, were eaſily overthrown by the winds, and, without interruption, remained on the places where they happened to fall. The foreſt, thus fallen, muſt neceſſarily have ſtopped up the currents, both from land and ſea; and turned into great lakes, what were before but temporary ſtreams. The working of the waters here, the conſumption and decay of rotten boughs and branches, and the vaſt increaſe of water-moſs which flouriſhes upon marſhy grounds, ſoon formed a covering over the trunks of the fallen trees, and raiſed the earth ſeveral feet above its former level. The earth thus every day ſwelling, by a continual increaſe from the ſediment of the waters, and by the lightneſs of the vegetable ſubſtances of which it was compoſed, ſoon overtopt the waters by which this intumeſcence was at firſt effected; ſo that it entirely got rid of its inundations, or only demanded a ſlight aſſiſtance from man for that purpoſe." This may be the origin of all bogs, which are formed by the putrefaction of vegetable ſubſtances, mixed with the mud and ſlime depoſited by waters, and at length acquiring a ſufficient conſiſtency.

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* Phil. Tranſ. vol. iv. part ii. p. 214.

From this we ſee what powerful effects the ſea is capable of producing upon its ſhores, either by overflowing ſome, or deſerting others; by altering the direction of theſe, and rendering thoſe craggy and precipitate, which before were ſhelving. But the influence it has upon theſe, is nothing to that which it has upon that great body of earth which forms its bottom. It is at the bottom of the ſea that the greateſt wonders are performed, and the moſt rapid changes are produced; it is there that the motion of the tides and the currents have their whole force, and agitate the ſubſtances of which their bed is compoſed. But all theſe are almoſt wholly hid from human curioſity; the miracles of the deep are performed in ſecret; and we have but little information from its abyſſes, except what we receive by inſpection at very ſhallow depths, or by the plummet, or from divers, who are known to deſcend from twenty to thirty fathom *.

The eye can reach but a very ſhort way into the depths of the ſea; and that only when its ſurface is glaſſy and ſerene. In many ſeas it perceives nothing but a bright ſandy plain at bottom, extending for ſeveral hundred miles, without an intervening object. But in others, particularly in the Red Sea, it is very different: the whole bottom of this extenſive bed of waters is, literally ſpeaking, a foreſt of ſub-marine plants, and corals formed by inſects for their habitation, ſometimes branching out to a great extent. Here are ſeen the mad-

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* Phil. Tranſ. vol. iv. part ii. p. 197.

repores, the ſponges, moſſes, ſea-muſhrooms, and other marine productions, covering every part of the bottom; ſo that ſome have even ſuppoſed to ſea the have taken its name from the colour of its plants below. However, theſe plants are by no means peculiar to this ſea, as they are found in great quantities in the Perſian Gulph, along the coaſts of Africa, and thoſe of Provence and Catalonia.

The bottom of many parts of the ſea near America preſents a very different, though a very beautiful appearance. This is covered with vegetables, which make it look as green as a meadow, and beneath are ſeen thouſands of turtles, and other ſea-animals feeding thereon.

In order to extend our knowledge of the ſea to greater depths, recourſe has been had to the plummet; which is generally made of a lump of lead of about forty pounds weight, faſtened to a cord*. This, however, only anſwers in moderate depths; for when a deep ſea is to be ſounded, the matter of which the cord is compoſed, being lighter than the water, floats upon it, and when let down to a conſiderable depth, its length ſo increaſes its ſurface, that it is often ſufficient to prevent the lead from ſinking; ſo that this may be the reaſon that ſome parts of the ſea are ſaid to have no bottom.

In general, we learn from the plummet, that the bottom of the ſea is tolerably even where it has been examined; and that the farther from the ſhore, the ſea is in general the deeper. Notwithſtanding, in the midſt of a great and unfathomable ocean, we often find an iſland raiſing its head, and ſingly braving its fury. Such iſlands may be conſidered as the mountains of the deep; and, could we for a moment imagine the waters of the ocean removed, or dried away, we ſhould probably find the inequalities of its bed reſembling thoſe that are found at land. Here extenſive plains; there valleys; and, in many places, mountains of amazing height. M. Buache has actually given us a map of that part of its bottom, which lies between Africa and America, taken from the ſeveral ſoundings of mariners: in it we find the ſame uneven ſurface that we do upon land, the ſame eminences, and the ſame depreſſions. In ſuch an imaginary proſpect, however, there would be this difference, that as the tops of land-mountains appear the moſt barren and rocky, the tops of ſea-mountains would be found the moſt verdant and fruitful.

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* Buffon, vol. ii. p. 5.

The plummet, which thus gives us ſome idea of the inequalities of the bottom, leaves us totally in the dark as to every other particular; recourſe, therefore, has been had to divers: theſe, either being bred up in this dangerous way of life, and accuſtomed to remain ſome time under water without breathing, or aſſiſted by means of a diving-bell, have been able to return ſome confuſed and uncertain accounts of the places below. In the great diving-bell improved by Dr. Halley, which was large enough to contain five men, and was ſupplied with freſh air by buckets, that alternately roſe and fell, they deſcended fifty fathom. In this huge machine, which was let down from the maſt of the ſhip, the doctor himſelf went down to the bottom, where, when the ſea was clear, and eſpecially when the ſun ſhone, he could ſee perfectly well to write or read, and much more to take up any thing that was underneath: at other times, when the water was troubled and thick, it was as dark as night below, ſo that he was obliged to keep a candle lighted at the bottom. But there was one thing very remarkable, that the water which from above was uſually ſeen of a green colour, when looked at from below, appeared to him of a very different one, caſting a redneſs upon one of his hands, like that of damaſk roſes*:—A proof of the ſea's taking its colour not from any thing floating in it, but from the different reflections of the rays of light. Upon the whole, the accounts we have received from the bottom, by this contrivance, are but few. We learn from it, and from divers in general, that while the ſurface of the ſea may be deformed by tempeſts, it is uſually calm and temperate below†; that ſome divers who have gone down when the weather was calm, and came up when it was tempeſtuous, were ſurpriſed at their not perceiving the change at the bottom. This, however, muſt not be ſuppoſed to obtain with regard to the tides, and the currents, as they are ſeen conſtantly ſhifting their bottom; taking their bed with great violence from one place, and depoſiting is upon another. We are informed, alſo, by divers, that the ſea grows colder in proportion as they deſcend to the bottom; that as far as the ſun's rays pierce, it is influenced by their warmth; but lower, the cold becomes almoſt intolerable. A perſon of quality, who had been himſelf a diver, as Mr. Boyle informs us, declared, that though he ſeldom deſcended above three or four fathoms, yet he found it ſo much colder than near the top, that he could not well endure it; and that being let down in a great diving-bell, although the water could not immediately touch him, he found the air extremely cold upon his firſt arrival at the bottom.

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* Newton's Optic, p. 56.

† Boyle, vol. iii. p. 242.

From divers alſo we learn, that the ſea in many places is filled with rocks at bottom; and, that among their clifts, and upon their ſides, various ſubſtances ſprout forward, which are either really vegetables, or the neſts of inſects, increaſed to ſome magnitude. Some of theſe aſſume the ſhape of beautiful flowers; and, tho' ſoft, when taken up, ſoon harden, and are kept in the cabinets of the curious.

But, of all thoſe divers who have brought us information from the bottom of the deep, the famous Nicola Peſce, whoſe performances are told us by Kircher, is the moſt celebrated. I will not ſo much as pretend to vouch for the veracity of Kircher's account, which he aſſures us he had from the archives of the kings of Sicily; but it may ſerve to enliven an heavy chapter. " In the times of Frederic, king of Sicily, there lived a celebrated diver, whoſe name was Nicolas, and who, from his amazing ſkill in ſwimming, and his perſeverance under water, was ſirnamed the *Fiſh*. This man had, from his infancy, been uſed to the ſea; and earned his ſcanty ſubſiſtence by diving for corals and oyſters; which he ſold to the villages on ſhore. His long acquaintance with the ſea, at laſt, brought it to be almoſt his natural element. He frequently was know to ſpend five days in the midſt of the waves, without any other proviſions than the fiſh which he caught there, and ate raw. He often ſwam over from Sicily to Calabria, a tempeſtuous and dangerous paſſage, carrying letters from the king. He was frequently known to ſwim among the gulphs of the Lipari iſlands, no way apprehenſive of danger.

"Some mariners out at ſea one day obſerved ſomething at ſome diſtance from them, which they regarded as a ſea-monſter; but upon its approach, it was known to be Nicholas, whom they took into their ſhip. When they aſked him whither he was going in ſo ſtormy and rough a ſea, and at ſuch a diſtance from land, he ſhewed them a packet of letters, which he was carrying to one of the towns of Italy, exactly done up in a leather bag, in ſuch a manner as that they could not be wetted by the ſea. He kept them thus company for ſome time on their voyage, converſing and aſking queſtions; and after eating a hearty meal with them, he took his leave, and, jumping into the ſea, purſued his voyage alone.

"In order to aid theſe powers of enduring in the deep, Nature ſeemed to have aſſiſted him in a very extraordinary manner; for the ſpaces between his fingers and toes were webbed, as in a gooſe; and his cheſt became ſo very capacious, that he could take in at one inſpiration, as much breath as would ſerve him for a whole day.

"The account of ſo extraordinary a perſon did not fail to reach the King himſelf; who, actuated by the general curioſity, ordered that Nicolas ſhould be brought before him. It was no eaſy matter to find Nicolas, who generally ſpent his time in the ſolitudes of the deep; but, at laſt, however, after much ſearching, he was found, and brought before his Majeſty. The curioſity of this monarch had been long excited by the accounts he had heard of the bottom of the gulph of Charybdis; he therefore conceived that it would be a proper opportunity to have more certain information; and commanded our poor diver to examine the bottom of this dreadful whirlpool: as an incitement to his obedience, he ordered a golden cup to be flung into it. Nicolas was not inſenſible of the danger to which he was expoſed; dangers beſt known only to himſelf; and he therefore preſumed to remonſtrate: but the hopes of the reward, the deſire of pleaſing the King, and the pleaſure of ſhewing his ſkill, at laſt prevailed. He inſtantly jumped into the gulph, and was ſwallowed as inſtantly up in its boſom. He continued for three quarters of an hour below; during which time the King and his attendants remained upon ſhore anxious for his fate; but he at laſt appeared, buffeting upon the ſurface, holding the cup in triumph in one hand, and making his way good among the waves with the other. It may be ſuppoſed he was received with applauſe, upon his arrival on ſhore; the cup was made the reward of his adventure; the King ordered him to be taken proper care of; and, as he was ſomewhat fatigued and debilitated by his labour, after a hearty meal, he was put to bed, and permitted to refreſh himſelf by ſleeping.

"When his ſpirits were thus reſtored, he was again brought to ſatisfy the King's curioſity with a narrative of the wonders he had ſeen; and his account was to the following effect:—He would never, he ſaid, have obeyed the King's commands, had he been apprized of half the dangers that were before him. There were four things, he ſaid, that rendered the gulph dreadful, not only to men, but even to the fiſhes themſelves: firſt, the force of the water burſting up from the bottom, which requires great ſtrength to reſiſt; ſecondly, the abruptneſs of the rocks, that on every ſide threatened deſtruction; thirdly, the force of the whirlpool, daſhing againſt thoſe rocks; and fourthly, the number and magnitude of the polypous fiſh, ſome of which appeared as large as a man, and which, every where ſticking againſt the rocks, projected their fibrous arms to entangle him. Being aſked how he was able ſo readily to find the cup that had been thrown in, he replied, that it happened to be flung by the waves into the cavity of a rock, againſt which he himſelf was urged in his deſcent. This account, however, did not ſatisfy the King's curioſity: being requeſted to venture once more into the gulph for further diſcoveries, he at firſt refuſed; but the King deſirous of having the moſt exact information poſſible of all things to be found in the gulph, repeated his ſolicitations; and, to give them ſtill greater weight, produced a larger cup than the former, and added alſo a purſe of gold. Upon theſe conſiderations, the unfortunate Peſſacola once again plunged into the whirlpool, and was never heard of more."

CHAP. XVIII.

A SUMMARY ACCOUNT OF THE MECHANICAL PROPERTIES OF AIR.

HAVING deſcribed the earth and the ſea, we now aſcend into that fluid which ſurrounds them both; and which, in ſome meaſure, ſupports and ſupplies all Animated Nature. As upon viewing the bottom of the ocean from its ſurface, we ſee an infinity of animals moving therein, and ſeeking food; ſo were ſome ſuperior being to regard the earth at a proper diſtance, he might conſider us in the ſame light: he might, from his ſuperior ſtation, behold a number of buſy little beings, immerſed in the aerial fluid, that every where ſurrounds them, and ſeduloufly employed in procuring the means of ſubſiſtence. This fluid, though too fine for the groſs perception of its inhabitants, might, to his nicer organs of ſight, be very viſible; and, while he at once ſaw into its operations, he might ſmile at the varieties of human conjecture concerning it: he might readily diſcern, perhaps, the height above the ſurface of the earth to which this fluid atmoſphere reaches; he might exactly determine that peculiar form of its parts which gives it the ſpring or elaſticity with which it is endued: he might diſtinguiſh which of its parts were pure incorruptible air, and which only made for a little time to aſſume the appearance, ſo as to be quickly returned back to the element from whence it came. But as for us, who are immerſed at the bottom of this gulph, we muſt be contented with a more confined knowledge; and, wanting a proper point of proſpect, remain ſatisfied with a combination of the effects.

One of the firſt things, that our ſenſes informs us of, is, that although the air is too fine for our ſight, it is very obvious to our touch. Although we cannot ſee the wind contained in a bladder, we can very readily feel its reſiſtance; and though the hurricane may want colour, we often fatally experience that it does not want force. We have equal experience of the air's ſpring or elaſticity: the bladder, when preſſed, returns again, upon the preſſure being taken away;

a bottle, when filled, often burſts, from the ſpring of air which is included.

So far the ſlighteſt experience reaches; but, by carrying experiment a little farther we learn, that air alſo is heavy: a round glaſs veſſel being emptied of its air, and accurately weighed, has been found lighter than when it was weighed with the air in it. Upon computing the ſuperior weight of the full veſſel, a cubic foot of air is found to weigh ſomething more than an ounce.

From this experiment, therefore, we learn, that the earth, and all things upon its ſurface, are every where covered with a ponderous fluid, which riſing very high over our heads, muſt be proportionably heavy. For inſtance, as in the ſea, a man at the depth of twenty feet ſuſtains a greater weight of water than a man at the depth of but ten feet; ſo will a man at the bottom of a valley have a greater weight of air over him, than a man on the top of a mountain.

From hence we may conclude, that we ſuſtain a very great weight of air; and although, like men walking at the bottom of the ſea, we cannot feel the weight which preſſes equally round us, yet the preſſure is not the leſs real. As in morals, we ſeldom know the bleſſings that ſurround us till we are deprived of them; ſo here we do not perceive the weight of the ambient fluid till a part of it is taken away. If, by any means, we contrive to take away the preſſure of the air from any one part of our bodies, we are ſoon made ſenſible of the weight upon the other parts. Thus, if we clap our hand upon the mouth of a veſſel from whence the air has been taken away, there will thus be air on one ſide, and none on the other; upon which, we ſhall inſtantly find the hand violently ſucked inwards; which is nothing more than the weight of the air upon the back of the hand that forces it into the ſpace which is empty below.

As by this experiment, we perceive that the air preſſes with great weight upon every thing on the ſurface of the earth, ſo by other experiments we learn the exact weight with which it preſſes. Firſt, if the air be exhauſted out of any veſſel, a drinking veſſel for inſtance*, and this veſſel be ſet with the mouth downwards in water, the water will riſe up into the empty ſpace, and fill the inverted glaſs; for the external air will, in this caſe, preſs up the water where there is no weight to reſiſt; as, one part of a bed being preſſed, makes the other parts, that have no weight upon them, riſe. In this caſe, as we ſaid, the water being preſſed without, will riſe in the glaſs; and would continue to riſe (if the empty glaſs were tall enough) thirty-two feet high. In fact, there have been pipes made purpoſely for this experiment, of above thirty-two feet high; in which, upon being exhauſted, the water has always riſen to the height of thirty-two feet: there it has always reſted, and never aſcended higher. From this, therefore, we learn, that the weight of the air which preſſes up the water, is equal to a pillar or column of water, which is thirty-two feet high; as it is juſt able to raiſe ſuch a column, and no more. In other words, the ſurface of the earth is every where covered with a weight of air, which is equivalent to a covering of thirty-two feet deep of water; or to a weight of twenty-nine inches and a half of quickſilver, which is known to be juſt as heavy as the former.

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* This may be done by burning a bit of paper in the ſame, and then quickly turning it down upon the water.

Thus we ſee that the air at the ſurface of the earth is juſt as heavy as thirty-two feet of water, or twenty-nine inches and a half of quickſilver; and it is eaſily found, by computation, that to raiſe water thirty-two feet, will require a weight of fifteen pounds upon every ſquare inch. Now, if we are fond of computations, we have only to calculate how many ſquare inches are in the ſurface of an ordinary human body, and allowing every inch to ſuſtain fifteen pounds, we may amaze ourſelves at the weight of air we ſuſtain. It has been computed, and found, that our ordinary load of air amounts to within a little of forty thouſand pounds: this is wonderful! but wondering is not the way to grow wiſe.

Notwithſtanding this be our ordinary load, and our uſual ſupply, there are at different times very great variations.— The air is not, like water, equally heavy at all ſeaſons; but ſometimes is lighter, and ſometimes more heavy. It is ſometimes more compreſſed, and ſometimes more elaſtic or ſpringy, which produces the ſame effects as an increaſe of its weight.

The air which at one time raiſes water thirty-two feet in the tube, and quickſilver twenty-nine inches, will not at another raiſe the one to thirty feet, or the other to twenty-ſix inches. This makes therefore a very great difference in the weight we ſuſtain; and we are actually known, by computation, to carry at one time four thouſand pounds of air more than at another.

The reaſon of this ſurpriſing difference in the weight of air, is either owing to its preſſure from above, or to an increaſe of vapour floating in it. Its increaſed preſſure is the conſequence of its ſpring or elaſticity, which cold and heat ſenſibly affect, and are continually changing.

This elaſticity of the air is one of its moſt amazing properties; and to which it ſhould ſeem nothing can ſet bounds. A body of air that may be contained in a nut-ſhell, may eaſily, with heat, be dilated into a ſphere of unknown dimenſions. On the contrary, the air contained in a houſe, may be compreſſed into a cavity not larger than the eye of a needle. In ſhort, no bounds can be ſet to its confinement or expanſion; at leaſt, experiment has hitherto found its attempts indefinite. In every ſituation, it retains its elaſticity; and the more cloſely we compreſs it, the more ſtrongly does it reſiſt the preſſure. If to the increaſing the elaſticity on one ſide by compreſſion, we increaſe it on the other ſide by heat, the force of both ſoon becomes irreſiſtible; and a certain French philoſopher ſuppoſed*, that air thus confined and expanding, was ſufficient for the exploſion of a world.

Many inſtruments have been formed to meaſure and determine theſe different properties of the air; and which ſerve ſeveral uſeful purpoſes. The barometer ſerves to meaſure its weight; to tell us when it is heavier, and when lighter. It is compoſed of a glaſs tube or pipe, of about thirty inches in length, cloſed up at one end; this tube is then filled with quickſilver; this done, the maker clapping his finger upon the open end, inverts the tube, and plunges the open end, finger and all, into a baſon of quickſilver, and then takes his finger away: now the quickſilver in the tube will, by its own weight, endeavour to deſcend into that in the baſon; but the external air, preſſing on the ſurface of the quickſilver in the baſon without, and no air being in the tube at top, the quickſilver will continue in the tube, being preſſed up, as was ſaid, by the air, on the ſurface of the baſon below. The height at which it is known to ſtand in the tube, is uſually about twenty-nine inches, when the air is heavy; but not above twenty-ſix, when the air is very light. Thus, by this inſtrument, we can, with ſome exactneſs, determine the weight of the air; and, of conſequence, tell before-hand the changes of the weather. Before fine dry weather, the air is charged with a variety of vapours, which float in it unſeen, and render it extremely heavy, ſo that it preſſes up the quickſilver; or, in other words, the barometer riſes. In moiſt, rainy weather, the vapours are waſhed down, or there is not heat ſufficient for them to riſe, ſo that the air is then ſenſibly lighter, and preſſes up the quickſilver with leſs force; or, in other words, the barometer is ſeen to fall. Our conſtitutions ſeem alſo to correſpond with the changes of the weather-glaſs; they are braced, ſtrong, and vigorous, with a large body of air upon them; they are languid, relaxed, and feeble, when the air is light, and refuſes to give our fibres their proper tone.

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* Monſieur Amontons.

But although the barometer thus meaſures the weight of the air with exactneſs enough for the general purpoſes of life, yet it is often affected with a thouſand irregularities, that no exactneſs in the inſtrument can remedy, nor no theory account for. When high winds blow, the quickſilver generally is low: it riſes higher in cold weather than in warm; and is uſually higher at morning and evening than at mid-day: it generally deſcends lower after rain than it was before it. There are alſo frequent changes in the air, without any ſenſible alteration in the barometer.

As the barometer is thus uſed in predicting the changes of the weather, ſo it is alſo ſerviceable in meaſuring the heights of mountains, which mathematicians cannot ſo readily do: for, as the higher we aſcend from the ſurface of the earth, the air becomes lighter, ſo the quickſilver in the barometer will deſcend in proportion. It is found to ſink at the rate of the tenth part of an inch for every ninety feet we aſcend; ſo that in going up a mountain, if I find the quickſilver fallen an inch, I conclude, that I am got upon an aſcent of near nine hundred feet high. In this there has been found ſome variation; into a detail of which, it is not the buſineſs of a natural hiſtorian to enter.

In order to determine the elaſticity of air, the wind-gun has been invented, which is an inſtrument variouſly made; but in all upon the principle of compreſſing a large quantity of air into a tube, in which there is an ivory ball, and then giving the compreſſed elaſtic air free power to act, and drive the ball as directed. The ball, thus driven, will pierce a thick board; and will be as fatal, at ſmall diſtances, as if driven with gunpowder. I do not know whether ever the force of this inſtrument has been aſſiſted by means of heat; certain I am, that this, which could be very eaſily contrived by means of phoſphorus, or any other hot ſubſtance applied to the barrel, would give ſuch a force as I doubt whether gunpowder itſelf could produce.

The air-pump is an inſtrument contrived to exhauſt the air from round a veſſel adapted to that purpoſe called a receiver. This method of exhauſting, is contrived in the ſimple inſtrument, by a piſton, like that of a ſyringe, going down into the veſſel, and thus puſhing out its air; which, by means of a valve, is prevented from returning into the veſſel again. But this, like all other complicated inſtruments, will be better underſtood by a minute inſpection, than an hour's deſcription: it may ſuffice here to obſerve, that by depriving animals, and other ſubſtances, of all air, it ſhews us what the benefits and effects of air are in ſuſtaining life, or promoting vegetation.

The digeſter is an inſtrument of ſtill more extraordinary effects than any of the former; and ſufficiently diſcovers the amazing force of air, when its elaſticity is augmented by fire. A common tea-kettle, if the ſpout were cloſed up, and the lid put firmly down, would ſerve to become a digeſter, if ſtrong enough. But the inſtrument uſed for this purpoſe, is a ſtrong metal pot, with a lid to ſcrew cloſe on, ſo that, when down, no air can get in or return: into this pot meat and bones are put, with a ſmall quantity of water, and then the lid ſcrewed cloſe: a lighted lamp is put underneath, and, what is very extraordinary, (yet equally true) in ſix or eight minutes the whole maſs, bones and all, are diſſolved into a jelly; ſo great is the force and elaſticity of the air contained within, ſtruggling to eſcape, and breaking in pieces all the ſubſtances with which it is mixed. Care, however, muſt be taken not to heat this inſtrument too violently; for then the incloſed air would become irreſiſtible, and burſt the whole, with, perhaps, a fatal exploſion.

There are numberleſs other uſeful inſtruments made to depend on the weight, the elaſticity, or the fluidity of the air, which do not come within the plan of the preſent work; the deſign of which is not to give an account of the inventions that have been made for determining the nature and properties of air, but a mere narrative of its effects. The deſcription of the pump, the forcing-pump, the fire-engine, the ſteam-engine, the ſyphon, and many others, belong not to the naturaliſt, but the experimental philoſopher: the one gives a hiſtory of Nature, as he finds ſhe preſents herſelf to him; and he draws the obvious picture: the other purſues her with cloſe inveſtigation, tortures her by experiment to give up her ſecrets, and meaſures her latent qualities with laborious preciſion. Much more, therefore, might be ſaid of the mechanical effects of air, and of the conjectures that have been made reſpecting the form of its parts; how ſome have ſuppoſed them to reſemble little hoops, coiled up in a ſpring; others, like fleeces of wool; others, that the parts are endued with a repulſive quality, by which, when ſqueezed together, they endeavour to fly off, and recede from each other. We might have given the diſputes relative to the height to which this body of air extends above us, and concerning which there is no agreement. We might have inquired how much of the air we breathe is elementary, and not reducible to any other ſubſtance; and of what denſity it would become, if it were ſuppoſed to be continued down to the centre of the earth. At that place we might, with the help of figures, and a bold imagination, have ſhewn it twenty thouſand times heavier than its bulk of gold. We might alſo prove it millions of times purer than upon earth, when raiſed to the ſurface of the atmoſphere. But theſe ſpeculations do not belong to natural hiſtory; and they have hitherto produced no great advantages in that branch of ſcience to which they more properly appertain.

CHAP. XIX.

AN ESSAY TOWARDS A NATURAL HISTORY OF THE AIR.

A LATE eminent philoſopher has conſidered our atmoſphere as one large chymical veſſel, in which an infinite number of various operations are conſtantly performing. In it all the bodies of the earth are continually ſending up a part of their ſubſtance by evaporation, to mix in this great alembic, and to float a while in common. Here minerals, from their loweſt depths, aſcend in noxious, or in warm vapours, to make a part of the general maſs; ſeas, rivers, and ſubterraneous ſprings, furniſh their copious ſupplies; plants receive and return their ſhare; and animals, that by living upon, conſume this general ſtore, are found to give it back in greater quantities, when they die*. The air, therefore, that we breathe, and upon which we ſubſiſt, bears very little reſemblance to that pure elementary body which was deſcribed in the laſt chapter; and which is rather a ſubſtance that may be conceived, than experienced to exiſt. Air, ſuch as we find it, is one of the moſt compounded bodies in all Nature. Water may be reduced to a fluid every way reſembling air, by heat; which, by cold, becomes water again. Every thing we ſee gives off its parts to the air, and has a little floating atmoſphere of its own round it. The roſe is encompaſſed with a ſphere of its own odorous particles; while the night-ſhade infects the air with ſcents of a more ungrateful nature. The perfume of muſk flies off in ſuch abundance, that the quantity remaining becomes ſenſibly lighter by the loſs. A thouſand ſubſtances that eſcape all our ſenſes, we know to be there; the powerful emanations of the load-ſtone, the effluvia of electricity, the rays of light, and the inſinuations of fire. Such are the various ſubſtances through which we move, and which we are conſtantly taking in at every pore, and returning again with imperceptible diſcharge!

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* Boyle, vol. ii. p. 593.

This great ſolution, or mixture of all earthly bodies, is continually operating upon itſelf; which, perhaps may be the cauſe of its unceaſing motion: but it operates ſtill more viſibly upon ſuch groſſer ſubſtances as are expoſed to its influence; for ſcarce any ſubſtance is found capable of reſiſting the corroding qualities of the air. The air, ſay the chymiſts, is a chaos, furniſhed with all kinds of ſalts and menſtruums; and, therefore, it is capable of diſſolving all kinds of bodies. It is well known, that copper and iron are quickly covered, and eaten with ruſt; and that in the climates near the equator, no art can keep them clean. In thoſe dreary countries, the inſtruments, knives, and keys, that are kept in the pocket, are nevertheleſs quickly encruſted; and the great guns, with every precaution, after ſome years, become uſeleſs. Stones, as being leſs hard, may be readily ſuppoſed to be more eaſily ſoluble. The marble of which the noble monuments of Italian antiquity are compoſed, although in one of the fineſt climates in the world, ſhew the impreſſions which have been made upon them by the air. In many places they ſeem worm-eaten by time; and, in others they appear crumbling into duſt. Gold alone ſeems to be exempted from this general ſtate of diſſolution; it is never found to contract ruſt, though expoſed never ſo long: the reaſon of this ſeems to be, that ſea-ſalt, which is the only menſtruum capable of acting upon, and diſſolving gold, is but very little mixed with the air; for ſalt being a very fixed body, and not apt to volatilize, and riſe with heat, there is but a ſmall proportion of it in the atmoſphere. In the elaboratories, and ſhops, however, where ſalt is much uſed, and the air is impregnated with it, gold is found to ruſt as well as other metals.

Bodies of a ſofter nature are obviouſly deſtroyed by the air*. Mr. Boyle ſays, that ſilks brought to Jamaica, will, if there expoſed to the air, rot, even while they preſerve their colour; but if kept therefrom, they both retain their ſtrength and gloſs. The ſame happens in Braſil, where their clothes, which are black, ſoon turn of an iron colour; though, in the ſhops, they preſerve their proper hue*. In theſe tropical climates alſo, ſuch are the putreſcent qualities of the air, that white ſugar will ſometimes be full of maggots. Drugs and plaiſters loſe their virtue, and become verminous. In ſome places they are obliged to expoſe their ſweetmeats by day in the ſun, otherwiſe the night air would quickly cauſe them to putrify. On the contrary, in the cold arctic regions, animal ſubſtances, during their winter, are never known to putrify; and meat may be kept for months without any ſalt whatſoever. This experiment happily ſucceeded with the eight Engliſhmen that were accidentally left upon the inhoſpitable coaſts of Greenland, at a place where ſeven Dutchmen had periſhed but a few years before: for killing ſome rein-deer for their ſubſiſtence, and having no ſalt to preſerve the fleſh to their great ſurpriſe, they ſoon found it did not want any, as it remained ſweet during their eight months continuance upon that ſhore.

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* Buffon, vol. iii. p. 62.

Theſe powers with which air is endued over unorganized ſubſtances, are exerted in a ſtill ſtronger manner over plants, animals of an inferior nature, and, laſtly, over man himſelf. Moſt of the beauty, and the luxuriance of vegetation, is well known to be derived from the benign influence of the air: and every plant ſeems to have its favourite climate, not leſs than its proper ſoil. The lower ranks of animals alſo, ſeem formed for their reſpective climates, in which only they can live. Man alone ſeems the child of every climate, and capable of exiſting in all. However, this peculiar privilege does not exempt him from the influences of the air; he is as much ſubject to its malignity, as the meaneſt inſect or vegetable.

With regard to plants, air is ſo abſolutely neceſſary for their life and preſervation, that they will not vegetate in an exhauſted receiver. All plants have within them a quantity of air, which ſupports and agitates their juices. They are continually imbibing freſh nutriment from the air, to increaſe this ſtore, and to ſupply the wants which they ſuſtain from evaporation. When, therefore, the external air is drawn from them, they are no longer able to ſubſiſt. Even that quantity of air which they before were poſſeſſed of, eſcapes through their pores, into the exhauſted receiver; and as this continues to be pumped away, they become languid, grow flaccid, and die. However, the plant or flower thus ceaſing to vegetate, is kept, by being ſecured from the external air, a much longer time ſweet than it would have continued, had it been openly expoſed.

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* Buffon, vol. iii. p. 68.

That air which is ſo neceſſary to the life of vegetables, is ſtill more ſo to that of animals; there are none found, how ſeemingly torpid ſoever, that do not require their needful ſupply. Fiſhes themſelves will not live in water from whence the air is exhauſted; and it is generally ſuppoſed that they die in frozen ponds, from the want of this neceſſary to animal exiſtence. Many have been the animals that idle curioſity has tortured in the priſon of a receiver, merely to obſerve the manner of their dying. We ſhall, from a thouſand inſtances, produce that of the viper, as it is known to be one of the moſt vivacious reptiles in the world; and as we ſhall feel but little compaſſion for its tortures. Mr. Boyle took a new-caught viper, and ſhutting it up into a ſmall receiver, began to pump away the air*. "At firſt, upon the air's being drawn away, it began to ſwell; ſome time after he had done pumping, it began to gape, and open its jaws; being thus compelled to open its jaws, it once more reſumed its former lankneſs; it then began to move up and down within, as if to ſeek for air, and after a while foamed a little, leaving the foam ſticking to the inſide of the glaſs; ſoon after the body and neck grew prodigiouſly tumid, and a bliſter appeared upon its back; a hour and a half after the receiver was exhauſted, the diſtended viper moved, and gave manifeſt ſigns of life; the jaws remained quite diſtended; as it were from beneath the epiglottis, came the black tongue, and reached beyond it; but the animal ſeemed, by its poſture, not to have any life: the mouth alſo was grown blackiſh within; and in this ſituation it continued for twenty three hours. But upon the air's being readmitted, the viper's mouth was preſently cloſed, and ſoon after opened again; and for ſome time thoſe motions continued, which argued the remains of life." Such is the fate of the moſt inſignificant or minute reptile that can be thus included. Mites, fleas, and even the little eels that are found ſwimming in vinegar, die for want of air. Not only theſe, but the eggs of theſe animals, will not produce in vacuo, but require air to bring them to perfection.

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* Boyle's Phyſico-Mechan. Exper. paſſim.

As in this manner air is neceſſary to their ſubſiſtence, ſo alſo it muſt be of a proper kind, and not impregnated with foreign mixtures. That factitious air which is pumped from plants or fluids, is generally, in a ſhort time, fatal to them. Mr. Boyle has given us many experiments to this purpoſe. After having ſhewn that all vegetable, and moſt mineral ſubſtances, properly prepared may afford air, by being placed in an exhauſted receiver, and this in ſuch quantities, that ſome have thought it a new ſubſtance, made by the alteration which the mineral or plant has undergone by the texture of its parts being looſened in the operation—having ſhewn, I ſay, that this air may be drawn in great quantities from vegetable, animal, or mineral ſubſtances, ſuch as apples, cherries, amber burnt, or hartſhorn*—he included a frog in artificial air, produced from paſte; in ſeven minutes ſpace it ſuffered convulſions, and at laſt lay ſtill, and being taken out, recovered no motion at all, but was dead. A bird incloſed in artificial air, from raiſins, died in a quarter of a minute, and never ſtirred more. A ſnail was put into the receiver, with air of paſte; in four minutes it ceaſed to move, and was dead, although it had ſurvived in vacuo for ſeveral hours: ſo that factitious air proved a greater enemy to animals than even a vacuum itſelf.

Air alſo may be impregnated with fumes that are inſtantly fatal to animals. The fumes of hot iron, copper, or any other heated metal, blown into the place where an animal is confined, inſtantly deſtroy it. We have already mentioned the vapours in the grotto Del Cane ſuffocating a dog. The ancients even ſuppoſed, that theſe animals, as they always ran with their noſes to the ground, were the firſt that felt any infection. In ſhort, it ſhould ſeem that the predominance of any one vapour, from any body, how wholſome ſoever in itſelf, becomes infectious; and that we owe the ſalubrity of the air to the variety of its mixture.

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* Boyle's Phyſico-Mechan. vol. ii. p. 598.

But there is no animal whoſe frame is more ſenſibly affected by the changes of the air than man. It is true, he can endure a greater variety of climates than the lower orders generally are able to do; but it is rather by the means which he has diſcovered of obviating their effects, than by the apparent ſtrength of his conſtitution. Moſt other animals can bear cold or hunger better, endure greater fatigues in proportion, and are ſatisfied with ſhorter repoſe. The variations of the climate, therefore, would probably effect them leſs, if they had the ſame means or ſkill in providing againſt the ſeverities of the change. However this be, the body of man is an inſtrument much more nicely ſenſible of the variations of the air, than any of thoſe which his own art has produced; for his frame alone ſeems to unite all their properties, being invigorated by the weight of the air, relaxed by its moiſture, enfeebled by its heat, and ſtiffened by its frigidity.

But it is chiefly by the predominance of ſome peculiar vapour, that the air becomes unfit for human ſupport. It is often found, by dreadful experience, to enter into the conſtitution, to mix with its juices, and to putrefy the whole maſs of blood. The nervous ſyſtem is not leſs affected by its operations; palſies and vertigoes are cauſed by its damps; and a ſtill more fatal train of diſtempers by its exhalations. In order that the air ſhould be wholeſome, it is neceſſary as we have ſeen, that it ſhould not be of one kind, but the compound of ſeveral ſubſtances; and the more various the compoſition, to all appearance the more ſalubrious. A man, therefore, who continues in one place, is not ſo likely to enjoy this wholeſome variety, as he who changes his ſituation; and, if I may ſo expreſs it, inſtead of waiting for a renovation of air, walks forward to meet his arrival. This mere motion, independent even of the benefits of exerciſe, becomes wholeſome, by thus ſupplying a great variety of that healthful fluid by which we are ſuſtained.

A thouſand accidents are found to encreaſe theſe bodies of vapour, that make one place more or leſs wholeſome than another. Heat may raiſe them in too great quantities; and cold may ſtagnate them. Minerals may give off their effluvia in ſuch proportion as to keep away all other kind of air; vegetables may render the air unwholeſome by their ſupply; and animal putrefaction ſeems to furniſh a quantity of vapour, at leaſt as noxious as any of the former. All theſe united, generally make up the maſs of reſpiration, and are, when mixed together, harmleſs; but any one of them, for a long time ſingly predominant, becomes at length fatal.

The effects of heat in producing a noxious quality in the air, are well known. Thoſe torrid regions under the Line are always unwholeſome. At Senegal, I am told, the natives conſider forty as a very advanced time of life, and generally die of old age at fifty. At Carthagena*, in America, where the heat of the hotteſt day ever known in Europe is continual, where, during their winter ſeaſon, theſe dreadful heats are united with a continual ſucceſſion of thunder, rain, and tempeſts, ariſing from their intenſeneſs, the wan and livid complexions of the inhabitants might make ſtrangers ſuſpect that they were juſt recovered from ſome dreadful diſtemper; the actions of the natives are conformable to their colour; in all their motions there is ſomewhat relaxed and languid; the heat of the climate even affects their ſpeech, which is ſoft and ſlow, and their words generally broken. Travellers from Europe retain their ſtrength and ruddy colour in that climate, poſſibly for three or four months; but afterwards ſuffer ſuch decays in both, that they are no longer to be diſtinguiſhed from the inhabitants by their complexion. However, this languid and ſpiritleſs exiſtence is frequently drawled on ſometimes even to eighty. Young perſons are generally moſt affected by the heat of the climate, which ſpares the more aged; but all, upon their arrival on the coaſts, are ſubject to the ſame train of fatal diſorders. Few nations have experienced the mortality of theſe coaſts, ſo much as our own: in our unſucceſsful attack upon Carthagena, more than three parts of our army were deſtroyed by the climate alone; and thoſe that returned from that fatal expedition, found their former vigour irretrivably gone. In our more fortunate expedition, which gave us the Havannah, we had little reaſon to boaſt of our ſucceſs; inſtead of a third, not a fifth part of the army were left ſurvivors of their victory, the climate being an enemy that even heroes cannot conquer.

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* Ulloa, vol. i. p. 42.

The diſtempers that thus proceed from the cruel malignity of thoſe climates, are many: that, for inſtance, called the *Chapotonadas*, carries off a multitude of people; and extremely thins the crews of European ſhips, whom gain tempts into thoſe inhoſpitable regions. The nature of this diſtemper is but little known, being cauſed in ſome perſons by cold, in others by indigeſtion. But its effects are far from being obſcure; it is generally fatal in three or four days: upon its ſeizing the patient, it brings on what is there called the *black vomit*, which is the ſad ſympton after which none are ever found to recover. Some, when the vomit attacks them, are ſeized with a delirium, that, were they not tied down, they would tear themſelves to pieces, and thus expire in the midſt of this furious paroxyſm. This diſorder, in milder climates, takes the name of the *bilious fever*, and is attended with milder ſymptoms, but very dangerous in all.

There are many other diſorders incident to the human body, that ſeem the offspring of heat; but to mention no other, that very laſſitude which prevails in all the tropical climates, may be conſidered as a diſeaſe. The inhabitants of India*, ſays a modern philoſopher, ſuſtain an unceaſing languor, from the heats of their climate, and are torpid in the midſt of profuſion. For this reaſon, the great Diſpoſer of Nature has clothed their country with trees of an amazing height, whoſe ſhade might defend them from the beams of the ſun; and whoſe continual freſhneſs might, in ſome meaſure, temperate their fierceneſs. From theſe ſhades, therefore, the air receives refreſhing moiſture, and animals a cooling protection. The whole race of ſavage animals retire, in the midſt of the day, to the very centre of the foreſts, not ſo much to avoid their enemy man, as to find a defence againſt the raging heats of the ſeaſon. This advantage which ariſes from ſhade in torrid climates, may probably afford a ſolution for that extraordinary circumſtance related by Boyle, which he imputes to a different cauſe. In the iſland of Ternate, belonging to the Dutch, a place that had been long celebrated for its beauty and healthfulneſs, the clove-trees grew in ſuch plenty, that they in ſome meaſure leſſened their own value: for this reaſon, the Dutch reſolved to cut down the foreſts, and thus to raiſe the price of the commodity: but they had ſoon reaſon to repent of their avarice; for ſuch a change enſued, by cutting down the trees, that the whole iſland, from being healthy and delightful, having loſt its charming ſhades, became extremely ſickly, and has actually continued ſo to this day. Boerhaave conſidered heat ſo prejudicial to health, that he was never ſeen to go near a fire.

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* Linnæi Amenitates, vol. v. p. 444.

An oppoſite ſet of calamities are the conſequence, in climates where the air is condenſed by cold. In ſuch places, all that train of diſtempers which are known to ariſe from obſtructed perſpiration, are very common*; eruptions, boils, ſcurvy, and a loathſome leproſy, that covers the whole body with a ſcurf, and white putrid ulcers. Theſe diſorders alſo, are infectious; and, while they thus baniſh the patient from ſociety, they generally accompany him to the grave. The men of thoſe climates ſeldom attain to the age of fifty; but the women, who do not lead ſuch laborious lives, are found to live longer.

The autumnal complaints which attend a wet ſummer, indicate the dangers of a moiſt air. The long continuance of an eaſt wind alſo, ſhews the prejudice of a dry one. Mineral exhalations, when copious, are every where known to be fatal; and although we probably owe the increaſe and luxuriance of vegetation to a moderate degree of their warmth, yet the natives of thoſe countries where there are mines in plenty, but too often experience the noxious effects of their vicinity. Thoſe trades alſo that deal in the preparations of metals of all kinds, are always unwholeſome; and the workmen, after ſome time, are generally ſeen to labour under palſies, and other nervous complaints. The vapours from ſome vegetable ſubſtances are well known to be attended with dangerous effects. The ſhade of the machinel tree, in America, is ſaid to be fatal, as was that of the juniper, if we may credit the ancients. Thoſe who walk through fields of poppies, or in any manner prepare thoſe flowers for making opium, are very ſenſibly affected with the drowſineſs they occaſion. A phyſician of Mr. Boyle's acquaintance, cauſing a large quantity of black hellebore to be pounded in a mortar, moſt of the perſons who were in the room, and eſpecially the perſon who pounded it, were purged by it, and ſome of them ſtrongly. He alſo gathered a certain plant in Ireland, which the perſon who beat in a mortar, and the phyſician who was ſtanding near, were ſo ſtrongly affected by, that their hands and faces ſwelled to an enormous ſize, and continued tumid for a long time after.

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* Krant's Hiſtory of Greenland, vol. i. p. 235.

But neither mineral nor vegetable ſteams are ſo dangerous to the conſtitution, as thoſe proceeding from animal ſubſtances, putrefying either by diſeaſe or death. The effluvia that comes from diſeaſed bodies, propagate that frightful catalogue of diſorders which are called *infectious*. The parts which compoſe vegetable vapours and mineral exhalations, ſeem groſs and heavy, in compariſon of theſe volatile vapours, that go to great diſtances, and have been deſcribed as ſpreading deſolation over the whole earth. They fly every where; penetrate every where; and the vapours that fly from a ſingle diſeaſe, ſoon render it epidemic.

The plague is the firſt upon the liſt in this claſs of human calamities. From whence this ſcourge of man's preſumption may have its beginning, is not well known; but we well know that it is propagated by infection. Whatever be the general ſtate of the atmoſphere, we learn, from experience, that the noxious vapours, though but ſingly introduced at firſt, taints the air by degrees; every perſon infected, tends to add to the growing malignity; and, as the diſorder becomes more general, the putreſcence of the air becomes more noxious, ſo that the ſymptoms are aggravated by continuance. When it is ſaid that the origin of this diſorder is unknown, it implies, that the air ſeems to be but little employed in firſt producing it. There are ſome countries, even in the midſt of Africa, that we learn have never been infected with it; but continue, for centuries, unmoleſted. On the contrary, there are others, that are generally viſited once a year, as in Egypt, which, nevertheleſs, ſeems peculiarly bleſſed with the ſerenity and temperature of its climate. In the former countries, which are of vaſt extent, and many of them very populous, every thing ſhould ſeem to diſpoſe the air to make the plague continual among them. The great heats of the climate, the unwholeſomeneſs of the food, the ſloth and dirt of the inhabitants, but, above all, the bloody battles which are continually fought among them, after which heaps of dead bodies are left unburied, and expoſed to putrefaction. All theſe one might think would be apt to bring the plague among them, and yet, nevertheleſs, we are aſſured by Leo Africanus, that in Numidia the plague is not known once in an hundred years; and that in Negroland, it is not known at all. This dreadful diſorder, therefore, muſt have its riſe, not from any previous diſpoſition of the air, but from ſome particular cauſe, beginning with one individual, and extending the malignity, by communication, till at laſt the air becomes actually tainted by the generality of the infection.

The plague which ſpread itſelf over the whole world, in the year 1346, as we are told by Mezeray, was ſo contagious, that ſcarge a village, or even a houſe, eſcaped being infected by it. Before it had reached Europe, it had been for two years travelling from the great kingdom of Cathay, where it began by a vapour moſt horridly fœtid; this broke out of the earth like a ſubterranean fire, and upon the firſt inſtant of its eruption, conſumed and deſolated above two hundred leagues of that country, even to the trees and ſtones.

In that great plague which deſolated the city of London, in the year 1665, a pious and learned ſchoolmaſter of Mr. Boyle's acquaintance, who ventured to ſtay in the city, and took upon him the humane office of viſiting the ſick and the dying, who had been deſerted by better phyſicians, averred, that being once called to a poor woman who had buried her children of the plague, he found the room where ſhe lay ſo little that it ſcarce could hold any more than the bed whereon ſhe was ſtretched. However, in this wretched abode, beſide her, in an open coffin, her huſband lay, who had ſome time before died of the ſame diſeaſe; and whom ſhe, poor creature, ſoon followed. But what ſhewed the peculiar malignity of the air, thus ſuffering from animal putrefaction, was, that the contagious ſteams had produced ſpots on the very wall of their wretched apartment: and Mr. Boyle's own ſtudy, which was, contiguous to a peſt-houſe, was alſo ſpotted in the ſame frightful manner. Happily for mankind, this diſorder, for more than a century, has not been known in our iſland; and, for this laſt age, has abated much of its violence, even in thoſe countries where it is moſt common. Diſeaſes, like empires, have their revolutions; and thoſe which for a while were the ſcourge of mankind, ſink unheard of, to give place to new ones, more dreadful, as being leſs underſtood.

For this revolution in diſorders, which has employed the ſpeculation of many, Mr. Boyle accounts in the following manner: "Since," ſays he, "there want not cauſes in the bowels of the earth, to make conſiderable changes amongſt the materials that Nature has plentifully treaſured up in thoſe magazines, and as thoſe noxious ſteams are abundantly ſupplied to the ſurface, it may not ſeem improbable, that in this great variety, ſome may be found capable of particularly affecting the human frame in a particular manner, and thus of producing new diſeaſes. The duration of theſe may be greater or leſs, according to the laſtingneſs of thoſe ſubterraneous cauſes that produced them. On which account, it need be no wonder that ſome diſeaſes have but a ſhort duration, and vaniſh not long after they appear; whilſt others may continue longer, as having under ground more ſettled and durable cauſes to maintain them."

From the recital of this train of miſchiefs produced by the air, upon minerals, plants, animals, and man himſelf, a gloomy mind may be apt to dread this indulgent nurſe of Nature as a cruel and an inexorable ſtep-mother: but it is far otherwiſe; and, although we are ſometimes injured, yet almoſt all the comforts and bleſſings of life ſpring from its propitious influence. It would be needleſs to obſerve, that it is abſolutely neceſſary for the ſupport of our lives; for of this, every moment's experience aſſures us. But how it contributes to this ſupport, is not ſo readily comprehended. All allow it to be a friend, to whoſe benefits we are conſtantly obliged; and yet, to this hour, philoſophers are divided as to the nature of the obligation. The diſpute is whether the air is only uſeful by its weight to force our juices into circulation*; or, whether, by containing a peculiar ſpirit, it mixes with the blood in our veſſels, and acts like a ſpur to their induſtry†. Perhaps it may exert both theſe uſeful offices at the ſame time. Its weight may give the blood its progreſſive motion, through the larger veſſels of the body; and its admixture with it, cauſe thoſe contractions of all the veſſels, which ſerve to force it ſtill more ſtrongly forward, through the minuteſt channels of the circulation. Be this as it may, it is well known, that that part of our blood which has juſt received the influx of the air in our bodies, is of a very different colour from that which has almoſt performed its circuit. It has been found, that the arterial blood which has been immediately mixed with the air in the lungs, and, if I may ſo expreſs it, is juſt beginning its journey through the body, is of a fine florid ſcarlet colour; while, on the contrary, the blood of the veins that is returning from having performed its duty, is of a blackiſh crimſon hue. Whence this difference of colour ſhould proceed, is not well underſtood; we only know the fact, that this florid colour is communicated by the air; and we are well convinced, that this air has been admitted into the blood for very uſeful purpoſes.

Beſides this vital principle in animals, the air alſo gives life and body to flame. A candle quickly goes out in an exhauſted receiver; for having ſoon conſumed the quantity of air, it then expires, for want of a freſh ſupply. There has been a flame contrived that will burn under water; but none yet has been found, that will continue to burn without air. Gunpowder, which is the moſt catching and powerful fire we know, will not go off in an exhauſted receiver; nay, if a train of gunpowder be laid, ſo as that one part may be fired in the open air, yet the other part in vacuo will remain untouched, and unconſumed. Wood alſo ſet on fire, immediately goes out; and its flame ceaſes upon removing the air; for ſomething is then wanting to preſs the body of the fire againſt that of the fuel, and to prevent the too ſpeedy diffuſion of the flame. We frequently ſee cooks, and others, whoſe buſineſs it is to keep up ſtrong fires, take proper precautions to exclude the beams of the ſun from ſhining upon them, which effectually puts them out. This they are apt to aſcribe to a wrong cauſe; namely, the operation of the light: but the real fact is, that the warmth of the ſun-beams leſſen and diſſipate the body of the air that goes to feed the flame; and the fire, of conſequence, languiſhes for want of a neceſſary ſupply.

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* Keil. Robinſon.

† Whytt upon vital and involuntary Motions.

The air, while it thus kindles fire into flame, is notwithſtanding found to moderate the rays of light, to diſſipate their violence, and to ſpread an uniform luſtre over every object. Were the beams of the ſun to dart directly upon us, without paſſing through this protecting medium, they would either burn us up at once, or blind us with their effulgence. But by going through the air, they are reflected, refracted, and turned from their direct courſe, a thouſand different ways; and thus are more evenly diffuſed over the face of Nature.

Among the other neceſſary benefits the air is of to us, one of the principal is its conveyance of ſound. Even the vibrations of a bell, which have the loudeſt effect that we know of, ceaſes to be heard, when under the receiver of an air-pump. Thus all the pleaſures we receive from converſation with each other, or from muſic, depend entirely upon the air.

Odours likewiſe are diffuſed only by the means of air; without this fluid to ſwim in, they would for ever remain torpid in their reſpective ſubſtances; and the roſe would affect us with as little ſenſations of pleaſure, as the thorn on which it grew.

Thoſe who are willing to augment the catalogue of the benefits we receive from this element, aſſert alſo, that taſtes themſelves would be inſipid, were it not that the air preſſes their parts upon the nerves of the tongue and palate, ſo as to produce their grateful effects. Thus, continue they, upon the tops of high mountains, as on the Peak of Teneriff, the moſt poignant bodies, as pepper, ginger, ſalt, and ſpice, have no ſenſible taſte, for want of their particles being thus ſent home to the ſenſory. But we owe the air ſufficient obligations, not to be ſtudious of admitting this among the number: in fact, all ſubſtances have their taſte, as well on the tops of the mountains, as in the bottom of the valley; and I have been one of many, who have ate a very ſavoury dinner on the Alps.

It is ſufficient, therefore, that we regard the air as the parent of health and vegetation; as a kind diſpenſer of light and warmth; and as the conveyer of ſounds and odours. This is an element of which Avarice will not deprive us; and which Power cannot monopolize. The treaſures of the earth, the verdure of the fields, and even the refreſhments of the ſtream, are too often ſeen going only to aſſiſt the luxuries of the great; while the leſs fortunate part of mankind ſtand humble ſpectators of their encroachments. But the air no limitations can bound, nor any land-marks reſtrain. In this benign element, all mankind can boaſt an equal poſſeſſion; and for this we all have equal obligations to Heaven. We conſume a part of it, for our own ſuſtenance, while we live; and, when we die, our putrefying bodies give back the ſupply, which, during life, we had accumulated from the general maſs.

CHAP. XX.

OF WINDS, IRREGULAR AND REGULAR.

WIND is a current of air. Experimental philoſophers produce an artificial wind, by an inſtrument called an *æolipile.* This is nothing more than an hollow copper ball, with a long pipe; a tea-kettle might be readily made into one, if it were entirely cloſed at the lid, and the ſpout left open; through this ſpout it is to be filled with water, and then ſet upon the fire, by which means it produces a violent blaſt, like wind, which continues while there is any water remaining in the inſtrument. In this manner water is converted into a ruſhing air; which, if caught as it goes out, and left to cool, is again quickly converted into its former element. Beſides this, as was mentioned in the former chapter, almoſt every ſubſtance contains ſome portions of air. Vegetables, or the bodies of animals left to putrefy produce it in a very copious manner. But it is not only ſeen thus eſcaping from bodies, but it may be very eaſily made enter into them. A quantity of air may be compreſſed into water, ſo as to be intimately blended with it. It finds a much eaſier admiſſion into wine, or any fermented liquor; and an eaſier ſtill, into ſpirits of wine. Some ſalts ſuck up the air in ſuch quantities, that they are made ſenſibly heavier thereby, and often are melted by its moſture. In this manner, moſt bodies, being found either capable of receiving or affording it, we are not to be ſurpriſed at thoſe ſtreams of air that are continually fleeting round the globe. Minerals, vegetables, and animals, contribute to increaſe the current; and are ſending off their conſtant ſupplies. Theſe, as they are differently affected by cold or heat, by mixture or putrefaction, all yield different quantities of air at different times; and the loudeſt tempeſts, and moſt rapid whirlwinds, are formed for their united contributions.

The ſun is the principal inſtrument in rarifying the juices of plants, ſo as to give an eſcape to their impriſoned air; it is alſo equally operative in promoting the putrefaction of animals. Mineral exhalations are more frequently raiſed by ſubterranean heat. The moon, the other planets, the ſeaſons, are all combined in producing theſe effects in a ſmaller degree. Mountains give a directions to the courſes of the air. Fires carry a current of air along their body. Night and day alternately chill and warm the earth, and produce an alternate current of its vapours. Theſe, and many other cauſes, may be aſſigned for the variety, and the activity of the winds, their continual change, and uncertain duration.

With us on land, as the wind proceeds from ſo many cauſes, and meets ſuch a variety of obſtacles, there can be but little hopes of ever bringing its motions to conform to theory; or of foretelling how it may blow a minute to come. The great Bacon, indeed, was of opinion, that by a cloſe and regular hiſtory of the winds, continued for a number of ages together, and the particulars of each obſervation reduced to general maxims, we might at laſt come to underſtand the variations of this capricious element; and that we could foretell the certainty of a wind, with as much eaſe as we now foretell the return of an eclipſe. Indeed, his own beginnings in this arduous undertaking, ſeem to ſpeak the poſſibility of its ſucceſs; but, unhappily for mankind, this inveſtigation is the work of ages, and we want a Bacon to direct the proceſs.

To be able, therefore, with any plauſibility, to account for the variations of the wind upon land, is not to be at preſent expected; and to underſtand any thing of their nature, we muſt have recourſe to thoſe places where they are more permanent and ſteady. This uniformity and ſteadineſs we are chiefly to expect upon the ocean. There, where there is no variety of ſubſtances to furniſh the air with various and inconſtant ſupplies, where there are no mountains to direct the courſe of its current, but where all is extenſively uniform and even; in ſuch a place, the wind ariſing from a ſimple cauſe, muſt have but one ſimple motion. In fact, we find it ſo. There are many parts of the world where the winds, that with us are ſo uncertain, pay their ſtated viſits. In ſome places they are found to blow one way by day, and another by night; in others, for one half of the year, they go in a direction contrary to their former courſe: but what is more extraordinary ſtill, there are ſome places where the winds never change, but for ever blow the ſame way. This is particularly found to obtain between the tropics in the Atlantic and Æthiopic oceans; as well as in the great Pacific ſea.

Few things can appear more extraordinary to a perſon who has never been out of our variable latitudes, than this ſteady wind, that for ever ſits in the ſail, ſending the veſſel forward; and as effectually preventing its return. He who has been taught to conſider that nothing in the world is ſo variable as the winds, muſt certainly be ſurpriſed to find a a place where there is nothing more uniform. With us their inconſtancy has become a proverb; with the natives of of thoſe diſtant climates they may talk of a friend or a miſtreſs as fixed and unchangeable as the winds, and mean a compliment by the compariſon. When our ſhips are once arrived into the proper latitudes of the great Pacific ocean, the mariner forgets the helm, and his ſkill becomes almoſt uſeleſs: neither ſtorms nor tempeſts are known to deform the glaſſy boſom of that immenſe ſheet of waters; a gentle breeze, that for ever blows in the ſame direction, reſts upon the canvas, and ſpeeds the navigator. In the ſpace of ſix weeks, ſhips are thus known to croſs an immenſe ocean, that takes more than ſo many months to return. Upon returning, the trade-wind, which has been propitious, is then avoided; the mariner is generally obliged to ſteer into the northern latitudes, and to take the advantage of every caſual wind that offers, to aſſiſt him into port. This wind, which blows with ſuch conſtancy one way, is known to prevail not only in the Pacific ocean, but alſo in the Atlantic, between the coaſts of Guinea and Braſil; and, likewiſe, in the Æthiopic ocean. This ſeems to be the great univerſal wind, blowing from the eaſt to the weſt, that prevails in all the extenſive oceans, where the land does not frequently break the general current. Were the whole ſurface of the globe an ocean, there would probably be but this one wind, for ever blowing from the eaſt, and purſuing the motions of the ſun weſtward. All the other winds ſeem ſubordinate to this; and many of them are made from the deviations of its current. To form, therefore, any conception relative to the variation of the wind in general, it is proper to begin with that which never varies.

There has been many theories to explain this invariable motion of the winds; among the reſt, we cannot omit that of Dr. Lyſter, for its ſtrangeneſs. "The ſea," ſays he, "in thoſe latitudes, is generally covered over with green weeds, for a great extent; and the air produced from the vegetable perſpiration of theſe, produces the trade-wind." The theory of Carteſius was not quite ſo abſurd. He alledged, that the earth went round faſter than its atmoſphere at the equator; ſo that its motion, from weſt to eaſt, gave the atmoſphere an imaginary one from eaſt to weſt; and thus an eaſt-wind was eternally ſeen to prevail. Rejecting thoſe arbitrary opinions, conceived without force, and aſſerted without proof, Dr. Halley has given one more plauſible; which ſeems to be the reigning ſyſtem of the day.

To conceive his opinion clearly, let us for a moment ſuppoſe the whole ſurface of the earth to be an ocean, and the air encompaſſing it on every ſide, without motion. Now it is evident, that that part of the air which lies directly under the beams of the ſun, will be rarified; and if the ſun remained for ever in the ſame place, there would a great vacuity in the air, if I may ſo expreſs it, beneath the place where the ſun ſtood. The ſun moving forward, from eaſt to weſt, this vacuity will follow too, and ſtill be made under it. But while it goes on to make new vacuities, the air will ruſh in to fill up thoſe the ſun has already made; in other words, as it is ſtill travelling forward, the air will continually be ruſhing in behind, and purſue its motions from eaſt to weſt. In this manner the air is put into motion by day; and by night; the parts continue to impel each other, till the next return of the ſun, that gives a new force to the circulation.

In this manner is explained the conſtant eaſt wind that is found blowing round the globe, near the equator. But it is alſo known, that as we recede from the equator on either ſide, we come into a trade-wind, that continually blows from the poles, from the north on one ſide, or the ſouth on the other, both directing towards the equator. This alſo proceeds from a ſimilar cauſe with the former; for the air being more rarified in thoſe places over which the ſun more directly darts its rays, the currents will come both from the north and the ſouth, to fill up the intermediate vacuity.

Theſe two motions, namely, the general one from eaſt to weſt, and the more particular one from both the Poles, will account for all the phænomena of trade-winds; which, if the whole ſurface of the globe were ſea, would undoubtedly be conſtant, and for ever continue to blow in one direction. But there are a thouſand circumſtances to break theſe air-currents into ſmaller ones; to drive them back againſt their general courſe; to raiſe or depreſs them; to condenſe them into ſtorms, or to whirl them in eddies. In conſequence of this, regard muſt be often had to the nature of the ſoil, the poſition of the high mountains, the courſe of the rivers, and even to the luxuriance of vegetation.

If a country lying directly under the ſun be very flat and ſandy, and if the land be low and extenſive, the heats occaſioned by the reflection of the ſun-beams, produces a very great rarefaction of the air. The deſerts of Africa, which are conformable to this deſcription, are ſcarce ever fanned by a breath of wind by day; but the burning ſun is continually ſeen blazing in intolerable ſplendour above them. For this reaſon, all along the coaſts of Guinea, the wind is always perceived blowing in upon land, in order to fill up the vacuity cauſed by the ſun's operation. In thoſe ſhores, therefore, the wind blows in a contrary direction to that of its general current; and is conſtantly found ſetting in from the weſt.

From the ſame cauſe it happens, that thoſe conſtant calms, attended with deluges of rain, are found in the ſame part of the ocean. For this tract being placed in the middle, between the weſterly winds blowing on the coaſt of Guinea, and the eaſterly trade-winds that move at ſome diſtance from ſhore, in a contrary direction, the tendency of that part of the air that lies between theſe two oppoſite currents, is indifferent to either, and ſo reſts between both in torpid ſerenity; and the weight of the incumbent atmoſphere, being diminiſhed by the continual contrary winds blowing from hence, it is unable to keep the vapours ſuſpended that are copiouſly borne thither; ſo that they fall in continual rains.

But it is not to be ſuppoſed, that any theory can account for all the phænomena of even thoſe winds that are known to be moſt regular. Inſtead, of a complete ſyſtem of the trade-winds, we muſt rather be content with an imperfect hiſtory. Theſe*, as was ſaid, being the reſult of a combination of effects, aſſume as great a variety as the cauſes producing them are various.

Beſides the great general wind above-mentioned, in thoſe parts of the Atlantic that lie under the temperate zone, a north wind prevails conſtantly during the months of October, November, December, and January. Theſe, therefore, are the moſt favourable months for embarking for the Eaſt-Indies, in order to take the benefit of theſe winds, for croſſing the line: and it has been often found, by experience, that thoſe who had ſet ſail five months before, were not in the leaſt farther advanced in their voyage, than thoſe who waited for the favourable wind. During the winter of Nova Zembla, and the other arctic countries, a north wind reigns almoſt continually. In the Cape de Verde iſlands, a ſouth wind prevails during the month of July. At the Cape of Good Hope, a north-weſt wind blows during the month of September. There are alſo regular winds, produced by various cauſes, upon land. The ancient Greeks were the firſt who obſerved a conſtant breeze, produced by the melting of the ſnows, in ſome high neighbouring countries. This was perceived in Greece, Thrace, Macedonia, and the Ægean ſea. The ſame kinds of winds are now remarked in the kingdom of Congo, and the moſt ſouthern parts of Africa. The flux and reflux of the ſea alſo produces ſome regular winds, that ſerve the purpoſes of trade; and, in general, it may be obſerved, that wherever there is a ſtrong current of water, there is a current of air that ſeems to attend it.

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* Buffon, vol. ii. p. 230.

Beſide theſe winds that are found to blow in one direction there are, as was ſaid before, others that blow for certain months of the year one way, and the reſt of the year the contrary way; theſe are called the *Monſoons*, from a famous pilot of that name, who firſt uſed them in navigation with ſucceſs*. In all that part of the ocean that lies between Africa and India, the eaſt winds begin at the month of January, and continue till about the commencement of June. In the month of Auguſt, or September, the contrary direction takes place; and the weſt winds prevail for three or four months. The interval between theſe winds, that is to ſay, from the end of June to the beginning of Auguſt, there is no fixed wind; but the ſea is uſually toſſed by violent tempeſts, proceeding from the north. Theſe winds are always ſubject to their greateſt variations, as they approach the land; ſo that on one ſide of the great peninſula of India, the coaſts are, for near half the year harraſſed by violent hurricanes, and northern tempeſts; while, on the oppoſite ſide, and all along the coaſts of Coromandel, theſe dreadful tempeſts are wholly unknown. At Java, and Ceylon, a weſt wind begins to reign in the month of September; but at fifteen degrees of ſouth latitude, this wind is found to be loſt, and the great general trade-wind from the eaſt, is perceived to prevail. On the contrary, at Cochin, in China, the weſt wind begins in March; ſo that theſe Monſoons prevail, at different ſeaſons, throughout the Indies. So that the mariner takes one part of the year to go from Java to the Moluccas; another from Cochin to Molucca: another from Molucca to China; and ſtill another to direct him from China to Japan.

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* Varenii Geographia Generalis, cap. 20.

There are winds alſo that may be conſidered as peculiar to certain coaſts; for example, the ſouth wind is almoſt conſtant upon the coaſts of Chili and Peru; weſtern winds almoſt conſtantly prevail on the coaſt of Terra Magellanica; and in the environs of the Straits le Maire. On the coaſts of Malabar, north and north-weſt winds prevail continually; along the coaſt of Guinea, the north-weſt wind is alſo very frequent; and, at a diſtance from the coaſts, the north-eaſt is always found prevailing. From the beginning of November to the end of December, a weſt wind prevails on the coaſts of Japan; and, during the whole winter, no ſhips can leave the port of Cochin, on account of the impetuoſity of the winds that ſet upon the coaſt. Theſe blow with ſuch vehemence, that the ports are entirely choked up with ſand; and even boats are not able to enter. However, the eaſt winds that prevail for the half of the year, clear the mouths of their harbours from the accumulations of the preceding winter, and ſet the confined ſhips at liberty. At the Straits of Babelmandel there is a ſouth wind that periodically returns, and which is always followed by a north-eaſt.

Beſide winds thus peculiar to certain coaſts, there are others found to prevail on all the coaſts, in warm climates; which, during the one part of the day, blow from the ſhore, and, during another part of it, blow from the ſea. The ſea-breeze, in thoſe countries, as Dampier obſerves, commonly ariſes in the morning, about nine, proceeding ſlowly, in a fine ſmall black curl, upon the ſurface of the water, and making its way to refreſh the ſhore. It is gentle at firſt, but increaſes gradually till twelve, then inſenſibly ſinks away, and is totally huſhed at five. Upon its ceaſing, the land-breeze begins to take its turn, which increaſes gradually till twelve at night, and is ſucceeded, in the morning, by the ſea-breeze again. Without all doubt, nothing could be more fortunate, for the inhabitants of the warm countries, where thoſe breezes blow, than this alternate refreſhment, which they feel at thoſe ſeaſons when it is moſt wanted. The heat, on ſome coaſts, would be inſupportable, were it not for ſuch a ſupply of air, when the ſun has rarified all that which lay more immediately under the coaſt. The ſea-breeze tempe-rates the heat of the ſun by day; and the land-breeze corrects the malignity of the dews, and vapours, by night.—Where theſe breezes, therefore, prevail, and they are very common, the inhabitants enjoy a ſhare of health, and happineſs, unknown to thoſe that live much farther up the country, or ſuch as live in ſimilar latitudes without this advantage. The cauſe of theſe obviouſly ſeems to ariſe from the rarefaction of the air by the ſun, as their duration continues with its appearance, and alters when it goes down. The ſun, it is obſerved, equally diffuſing his beams upon land and ſea, the land, being a more ſolid body than the water, receives a greater quantity of heat, and reflects it more ſtrongly. Being thus, therefore, heated to a greater degree than the waters, it, of conſequence, drives the air from land out to ſea; but, its influence being removed, the air returns to fill up the former vacuity. Such is the uſual method of accounting for this phænomenon; but, unfortunately, the ſea and land breezes are viſitants that come at all hours. On the coaſts of Malabar*, the land-breezes begin at midnight, and continue till noon; then the ſea-breezes take their turn, and continue till midnight. While again, at Congo, the land-breezes begin at five, and continue till nine the next day.

But, if the cauſe of theſe be ſo inſcrutable, that are, as we ſee, tolerably regular in their viſitations, what ſhall we ſay to the winds of our own climate, that are continually ſhifting, and incapable of reſt? Some general cauſes may be aſſigned, which nothing but particular experience can apply. And, in the firſt place, it may be obſerved, that clouds, and heat, and in ſhort, whatever either increaſes the denſity or the elaſticity of the air, in any one place, will produce a wind there: for the increaſed activity of the air thus preſſing more powerfully on the parts of it that are adjacent, will drive them forward, and thus go on, in a current, till the whole comes to an equality.

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* Buffon, vol. ii. p. 252.

In this manner, as a denſer air produces a wind on one hand; ſo will any accident, that contributes to lighten the air, produce it on the other: for, a lighter air may be conſidered as a vacuity, into which the neighbouring air will ruſh: and hence it happens, that when the barometer marks a peculiar lightneſs in the air, it is no wonder that it foretells a ſtorm.

The winds upon large waters are generally more regular than thoſe upon land. The wind at ſea generally blows with an even ſteady gale; the wind at land puffs by intervals, increaſing its ſtrength, and remitting it, without any apparent cauſe. This, in a great meaſure, may be owing to the many mountains, towers, or trees, that it meets in its way, all contributing either to turn it from its courſe, or interrupt its paſſage.

The eaſt wind blows more conſtantly than any other, and for an obvious reaſon: all other winds are, in ſome meaſure, deviations from it, and partly may owe their origin thereto. It is generally likewiſe, the moſt powerful, and for the ſame reaſon.

There are often double currents of the air. While the wind blows one way, we frequently ſee the clouds move another. This is generally the caſe before thunder; for it is well known that the thunder cloud always moves againſt the wind: the cauſe of this ſurpriſing appearance has hitherto remained a ſecret. From hence we may conclude, that weathercocks only inform us of that current of the air, which is near the ſurface of the earth; but are often erroneous with regard to the upper regions; and, in fact, Derham has often found them erroneous.

Winds are generally more powerful on elevated ſituations than on the plain, becauſe their progreſs is interrupted by fewer obſtacles. In proportion as we aſcend the heights of a mountain, the violence of the weather ſeems to increaſe, until we have got above the region of ſtorms, where all is uſually calm and ſerene. Sometimes, however, the ſtorms riſe even to the tops of the higheſt mountains; as we learn from thoſe who have been on the Andes, and as we are convinced by the deep ſnows that crown even the higheſt.

Winds blowing from the ſea are generally moiſter, and more attended with rains, than thoſe which blow over extenſive tracts of land; for the ſea gives off more vapours to the air, and theſe are rolled foward upon land, by the wind's blowing from thence *. For this reaſon our eaſterly winds, that blow from the continent, are dry, in compariſon of thoſe that blow from the ſurface of the ocean, with which we are ſurrounded on every quarter.

In general the winds are more boiſterous in ſpring and autumn than at other ſeaſons: for that being the time of high tides, the ſea may communicate a part of its motions to the winds. The ſun and moon, alſo, which then have a greater effect upon the waters, may alſo have ſome influence upon the winds; for, there being a great body of air ſurrounding the globe, which, if condenſed into water, would cover it to the depth of thirty-two feet, it is evident that the ſun and moon will, to a proportionable degree, affect the atmoſphere, and make a tide of air. This tide will be ſcarce perceivable, indeed; but, without doubt, it actually exiſts; and may contribute to increaſe the vernal and autumnal ſtorms, which are then known to prevail

Upon narrowing the paſſage through which the air is driven, both the denſity and the ſwiftneſs of the wind is increaſed. For as currents of water flow with greater force and rapidity by narrowing their channels, ſo alſo will a current of air, driven through a contracted ſpace, grow more violent and irreſiſtible. Hence we find thoſe dreadful ſtorms that prevail in the defiles of mountains, where the wind, puſhing from behind through a narrow channel, at once increaſes in ſpeed and denſity, levelling, or tearing up, every obſtacle that riſes to obſtruct its paſſage.

Winds reflected from the ſides of mountains and towers, are often found to be more forceful than thoſe in direct progreſſion. This we frequently perceive near lofty buildings, ſuch as churches or ſteeples, where winds are generally known to prevail, and are much more powerful than at

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* Derham Phyſico-Theol.

ſome diſtance. The air, in this caſe, by ſtriking againſt the ſide of the building, acquires additional denſity, and therefore, blows with more force.

Theſe differing degrees of denſity, which the air is found to poſſeſs, ſufficiently ſhew that the force of the winds do not depend upon their velocity alone; ſo that thoſe inſtruments called *anemometers*, which are made to meaſure the velocity of the wind, will by no means give us certain information of the force of the ſtorm. In order to eſtimate this with exactneſs we ought to know its denſity; which alſo theſe are not calculated to diſcover. For this reaſon we often ſee ſtorms, with very powerful effects, that do not ſeem to ſhew any great ſpeed; and, on the contrary, we ſee theſe wind meaſurers go round, with great ſwiftneſs, when ſcarce any damage has followed from the ſtorm.

Such is the nature, and the inconſtancy, of the irregular winds with which we are beſt acquainted. But their effects are much more formidable in thoſe climates, near the tropics, where they are often found to break in upon the ſteady courſe of the trade-winds, and to mark their paſſage with deſtruction. With us, the tempeſt is but rarely known, and its ravages are regiſtered as an uncommon calamity; but in the countries that lie between the tropics, and for a good ſpace beyond them, its viſits are frequent, and its effects anticipated. In theſe regions the winds vary their terrors; ſometimes involving all things in a ſuffocating heat; ſometimes mixing all the elements of fire, air, earth, and water together; ſometimes, with a momentary ſwiftneſs, paſſing over the face of the country, and deſtroying all things in their paſſage; and ſometimes raiſing whole ſandy deſerts in one country, to depoſit them upon ſome other. We have little reaſon, therefore, to envy theſe climates the luxuriance of their ſoil, or the brightneſs of their ſkies. Our own muddy atmoſphere, that wraps us round in obſcurity, though it fails to gild our proſpects with ſun-ſhine, or our groves with fruitage, nevertheleſs anſwers the calls of induſtry. They may boaſt of a plentful, but precarious harveſt; while, with us, the labourer toils in a certain expectation of a moderate, but a happy return.

In Egypt*, a kingdom ſo noted for its fertility, and the brightneſs of its atmoſphere, during ſummer, the ſouth winds are ſo hot, that they almoſt ſtop reſpiration; beſides which, they are charged with ſuch quantities of ſand, that they ſometimes darken the air, as with a thick cloud. Theſe ſands are ſo fine, and driven with ſuch violence, that they penetrate every where, even into cheſts, be they ſhut ever ſo cloſely. If theſe winds happen to continué for any length of time, they produce epidemic diſeaſes; and are often followed by a great mortality. It is alſo found to rain but very ſeldom in that country; however, the want of ſhowers is richly compenſated by the copiouſneſs of their dews, which greatly tend to promote vegetation.

In Perſia, the winter begins in November, and continues till March. The cold at that time is intenſe enough to congeal the water; and ſnow falls in abundance upon their mountains. During the months of March and April, winds ariſe, that blow with great force, and ſeems to uſher in the heats of ſummer. Theſe return again, in autumn, with ſome violence; without, however, producing any dreadful effects. But, during their ſummer, all along the coaſts of the Perſian gulph, a very dangerous wind prevails, which the natives call the *Sameyel*, ſtill more dreadful and burning than that of Egypt, and attended with inſtant and fatal effects. This terrible blaſt, which was, perhaps, the peſtilence of the ancients, inſtantly kills all thoſe that it involves in its paſſage. What its malignity conſiſts in, none can tell, as none have ever ſurvived its effects, to give information. It frequently, as I am told, aſſumes a viſible form; and darts, in a kind of bluiſh vapour, along the ſurface of the country. The natives, not only of Perſia, but of Arabia, talk of its effects with terror; and their poets have not failed to heighten them, with the aſſiſtance of imagination. They have deſcribed it as under the conduct of a miniſter of vengeance, who governs its terrors, and raiſes, or depreſſes it, as he thinks proper†. Theſe deadly winds are alſo known along the coaſts of India, at Necapatan, Maſulipatan, and Petapoli. But, luckily for mankind, the ſhortneſs of their duration diminiſhes the injuries that might enſue from their malignity.

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* Buffon, vol. ii. p. 258.

† Herbelot, Bibliotheque Oriental.

The Cape of Good Hope, as well as many iſlands in the Weſt-Indies, are famous for their hurricanes, and that extraordinary kind of cloud which is ſaid to produce them. This cloud, which is the fore-runner, of an approaching hurricane, and that extraordinary kind of cloud which is ſaid to produce them. This cloud, which is the fore-runner of an approaching hurricane, appears, when firſt ſeen, like a ſmall black ſpot, on the verge of the horizon; and is called, by ſailors, *the bull's eye*, from being ſeen ſo minute at a vaſt diſtance. All this time, a perfect calm reigns over the ſea and land, while the cloud grows gradually broader as it approaches. At length, coming to the place where its fury is to fall, it inveſts the whole horizon with darkneſs. During all the time of its approach, an hollow murmur is heard in the cavities of the mountains; and beaſts and animals, ſenſible of its approach, are ſeen running over the fields, to ſeek for ſhelter. Nothing can be more terrible than its violence when it begins. The houſes in thoſe countries, which are made of timber, the better to reſiſt its fury, bend to the blaſt like oſiers, and again recover their rectitude. The ſun, which, but a moment before, blazed with meridian ſplendor, is totally ſhut out; and a midnight darkneſs prevails, except that the air is inceſſantly illuminated with gleams of lightning, by which one can eaſily ſee to read. The rain falls, at the ſame time, in torrents; and its deſcent has been reſembled to what pours from the ſpouts of our houſes after a violent ſhower. Theſe hurricanes are not leſs offenſive to the ſenſe of ſmelling alſo; and never come without leaving the moſt noiſome ſtench behind them. If the ſeamen alſo lay by their wet clothes, for twenty-four hours, they are all found ſwarming with little white maggots, that were brought with the hurricane. Our firſt mariners, when they viſited theſe regions, were ignorant of its effects, and the ſigns of its approach; their ſhips, therefore, were daſhed to the bottom at the firſt onſet; and numberleſs were the wrecks which the hurricane occaſioned. But, at preſent, being forwarned of its approach, they ſtrip their maſts of all their ſails, and thus patiently abide its fury. Theſe hurricanes are common in all the tropical climates. On the coaſts of Guinea they have frequently three, or four, in a day, that thus ſhut out the heavens, for a litle ſpace; and, when paſt, leave all again in former ſplendor. They chiefly prevail, on that coaſt, in the intervals of the trade-winds; the approach of which clears the air of its meteors, and gives theſe mortal ſhowers that little degree of wholeſomeneſs which they poſſeſs. They chiefly obtain there during the months of April and May; they are known, at Loango, from January to April; on the oppoſite coaſt of Africa, the hurricane ſeaſon begins at May; and, in general, whenever a trade-wind begins to ceaſe, theſe irregular tempeſts are found to exert their fury.

All this is terrible; but there is a tempeſt, known in thoſe climates, more formidable than any we have hitherto been deſcribing, which is called, by the Spaniards, a *Tornado*. As the former was ſeen arriving from one part of the heavens, and making a line of deſtruction; ſo the winds in this ſeem to blow from every quarter, and ſettle upon one deſtined place, with ſuch fury, that nothing can reſiſt their vehemence. When they have all met, in their central ſpot, then the whirlwind begins with circular rapidity. The ſphere every moment widens, as it continues to turn, and catches every object that lies within its attraction. This, alſo, like the former, is preceded by a flattering calm; the air is every where huſhed; and the ſea is as ſmooth as poliſhed glaſs: however, as its effects are more dreadful than thoſe of the ordinary hurricane, the mariner tries all the power of his ſkill to avoid it; which, if he fails of doing, there is the greateſt danger of his going to the bottom. All along the coaſts of Guinea, beginning about two degrees north of the line, and ſo downward, lengthwiſe, for about a thouſand miles, and as many broad, the ocean is unnavigable, upon account of theſe tornados. In this torpid region there reigns unceaſing tornados, or continual calms; among which, whatever ſhip is ſo unhappy as to fall, is totally deprived of all power of eſcaping. In this dreadful repoſe of all the elements, the ſolitary veſſel is obliged to continue, without a ſingle breeze to aſſiſt the mariner's wiſhes, except thoſe whirlwinds, which only ſerve to increaſe his calamnity. At preſent, therefore, this part of the ocean is totally avoided;

and, although there may be much gold along the coaſts of that part of Africa, to tempt Avarice, yet there is ſomething, much more dreadful than the fabled dragon of antiquity, to guard the treaſure. As the internal parts of that country are totally unknown to travellers, from their burning ſands and extenſive deſerts, ſo here we find a vaſt tract of ocean, lying off its ſhores, equally unviſited by the mariner.

But of all thoſe terrible tempeſts that deform the face of Nature, and repreſs human preſumption, the ſandy tempeſts of Arabia and Africa, are the moſt terrible, and ſtrike the imagination moſt ſtrongly. To conceive a proper idea of theſe, we are by no means to ſuppoſe them reſembling thoſe whirlwinds of duſt that we ſometimes ſee ſcattering in our air, and ſprinkling their contents upon our roads, or meadows. The ſand-ſtorm of Africa exhibits a very different appearance. As the ſand of which the whirlwind is compoſed, is exceſſively fine, and almoſt reſembles the parts of water, its motion entirely reſembles that of a fluid; and the whole plain ſeems to float onward, like a ſlow inundation. The body of ſand thus rolling, is deep enough to bury houſes and palaces in its boſom: travellers who are croſſing thoſe extenſive deſerts perceive its approach at a diſtance; and, in general, have time to avoid it, or turn out of its ways, as it generally extends but to a moderate breadth. However, when it is extremely rapid, or very extenſive, as ſometimes is the caſe, no ſwiftneſs, no art, can avail; nothing then remains, but to meet death with fortitude, and ſubmit to be buried alive with reſignation.

It is happy for us of Britain, that we have no ſuch calamity to fear; for, from this, even ſome parts of Europe are not entirely free. We have an account given us, in the Hiſtory of the French Academy, of a miſerable town in France, that is conſtantly in danger of being buried under a ſimilar inundation; with which I will take leave to cloſe this chapter. "In the neighbourhood of St. Paul de Leon, in Lower Brittany*, there lies a tract of country along the ſea-ſide, which before the year 1666 was inhabited, but now lies deſerted, by reaſon of the ſands which cover it, to the height of twenty feet; and which every year advance more and more in land, and gain ground continually. From the time mentioned above, the ſand has buried more than ſix leagues of the country inward; and it is now but a half a league from the town of St. Paul; ſo that, in all appearance, the inhabitants muſt be obliged to abandon it entirely. In the country that has been overwhelmed, there are ſtill to be ſeen the tops of ſome ſteeples peeping through the ſand, and many chimnies that ſtill remain above this ſandy ocean. The inhabitants, however, had ſufficient time to eſcape; but being deprived of their little all, they had no other reſource but begging for their ſubſiſtence. This calamity chiefly owes its advancement to a north or an eaſt wind, raiſing the ſand, which is extremely fine, in ſuch great quantities, and with ſuch velocity, that M. Deſlands, who gave the account, ſays, that while he was walking near the place, during a moderate breeze of wind, he was obliged, from time to time to ſhake the ſand from his clothes and his hat, on which it was lodged in great quantities, and made them too heavy to be eaſily borne. Still further, when the wind was violent, it drove the ſand acroſs a little arm of the ſea, into the town of Roſcoff, and covered the ſtreets of that place two feet deep; ſo that they have been obliged to carry it off in carts. It may alſo be obſerved, that there are ſeveral particles of iron mixed with the ſand, which are readily affected by the loadſtone. The part of the coaſt that furniſhes theſe ſands, is a tract of about four leagues in length; and is upon a level with the ſea at high-water. The ſhore lies in ſuch a manner as to leave its ſands ſubject only to the north and eaſt winds, that bear them farther up the ſhore. It is eaſy to conceive how the ſame ſand that has at one time been borne a ſhort way in land, may, by ſome ſucceeding and ſtronger blaſt, be carried up much higher; and thus the whole may continue advancing forward, deluging the plain, and totally deſtroying its fertility. At the ſame time the ſea, from whence this deluge of ſand proceeds, may furniſh it in inexhauſtible quantities. This unhappy country, thus overwhelmed in ſo ſingular a manner, may well juſtify what the ancients and the moderns have reported concerning thoſe tempeſts of ſand in Africa, that are ſaid to deſtroy villages, and even armies, in their boſom."

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* Hiſtoire de l'Académie des Sciences, an. 1722.

CHAP. XXI.

OF METEORS, AND SUCH APPEARANCES AS RESULT FROM A COMBINATION OF THE ELEMENTS.

IN proportion as the ſubſtances of Nature are more compounded and combined, their appearances become more inexplicable and amazing. The properties of water have been very nearly aſcertained. Many of the qualities of air, earth, and fire, have been diſcovered, and eſtimated; but when theſe come to be united by Nature, they often produce a reſult which no artificial combinations can imitate; and we ſtand ſurpriſed, that although we are poſſeſſed of all thoſe ſubſtances which Nature makes uſe of, ſhe ſhews herſelf a much more various operator than the moſt ſkilful chymiſt ever appeared to be. Every cloud that moves, and every ſhower that falls, ſerves to mortify the philoſopher's pride, and to ſhew him hidden qualities in air and water, that he finds it difficult to explain. Dews, hail, ſnow, and thunder, are not leſs difficult for being more common. Indeed, when we reflect on the manner in which Nature performs any one of theſe operations, our wonder increaſes. To ſee water, which is heavier than air, riſing in air, and then falling in a form ſo very different from that in which it roſe; to ſee the ſame fluid at one time deſcending in the form of hail, at another in that of ſnow; to ſee two clouds by daſhing againſt each other, producing an electrical fire, which no watery compoſition that we know of can effect; theſe, I ſay, ſerve ſufficiently to excite our wonder; and ſtill the more, in proportion as the objects are ever preſſing on our curioſity. Much, however, has been written concerning the manner in which Nature operates in theſe productions; as nothing is ſo ungrateful to mankind as hopeleſs ignorance.

And firſt, with regard to the manner in which water evaporates, and riſes to form clouds, much has been advanced, and many theories deviſed. All water*, ſay ſome, has a quantity of air mixed with it; and the heat of the ſun darting down, diſengages the particles of the air from the groſſer fluid: the ſun's rays being reflected back from the water, carry back with them thoſe bubbles of air and water, which, being lighter than the condenſed air, will aſcend till they meet with a more rarified air; and they will then ſtand ſuſpended. Experience, however, proves nothing of all this. Particles of air or fire, are not thus known to aſcend with a thin coat of water; and, in fact, we know the little particles of ſteam are ſolid drops of water. But beſides this, water is known to evaporate more powerfully in the ſevereſt froſt, than when the air is moderately warm*. Dr. Hamilton, therefore, of the univerſity of Dublin, rejecting this theory, has endeavoured to eſtabliſh another. According to him, as aqua-fortis is a menſtruum that diſſolves iron, and keeps it mixed in the fluid; as aqua-regia is a menſtruum that diſſolves gold; or as water diſſolves ſalts to a certain quantity; ſo air is a menſtruum that corrodes and diſſolves a certain quantity of water, and keeps it ſuſpended above. But however ingenious this may be, it can hardly be admitted; as we know, by Mariotte's experiment†, that if water and air be encloſed together, inſtead of the air's acting as a menſtruum upon the water, the water will act as a menſtruum upon the air, and take it all up. We know alſo, that of two bodies, that which is moſt fluid and penetrating, is moſt likely to be the menſtruum of the other; but water is more fluid and penetrating than air, and therefore the moſt likely of the two to be the menſtruum. We know that all bodies are more ſpeedily acted upon, the more their parts are brought into contact with the menſtrum that diſſolves them: but water, encloſed with compreſſed air, is not the more diminiſhed thereby‡. In ſhort, we know, that cold, which diminiſhes the force of other menſtruums, is often found to promote evaporation. In this variety of opinion, and uncertainty of conjecture, I cannot avoid thinking that a theory of evaporation may be formed upon very ſimple and obvious principles, and embarraſſed, as far as I conceive, with very few objections.

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* Spectacle de la Nature, vol. iii.

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* Memoires de l'Académie des Sciences, an. 1705.

† Mariotte, de la Nature de l'Air, p. 97, 106.

‡ See Boyle's Works, vol. ii. p. 619.

We know that a repelling power prevails in Nature, not leſs than an attractive one. This repulſion prevails ſtrongly between the body of fire and that of water. If I plunge the end of a red hot bar of iron into a veſſel of water, the fluid riſes, and large drops of it fly up in all manner of directions, every part bubbling and ſteaming until the iron be cold. Why may we not, for a moment, compare the rays of the ſun, darted directly upon the ſurface of the water, to ſo many bars of red hot iron; each bar, indeed, infinitely ſmall, but not the leſs powerful? In this caſe, wherever a ray of fire darts, the water, from its repulſive quality, will be driven on all ſides; and, of conſequence, as in the caſe of the bar of iron, a part of it will riſe. The parts thus riſing, however, will be extremely ſmall; as the ray that darts is extremely ſo. The aſſemblage of the rays darting upon the water in this manner, will cauſe it to riſe in a light thin ſteam above the ſurface; and as the parts of this ſteam are extremely minute, they will be lighter than air, and, conſequently float upon it. There is no need for ſuppoſing them bubbles of water, filled with fire; for any ſubſtance, even gold itſelf, will float on air, if its parts be made ſmall enough; or, in other words, if its ſurface be ſufficiently increaſed. This water, thus diſengaged from the general maſs, will be ſtill farther attenuated and broken by the reflected rays, and, conſequently, more adapted for aſcending.

From this plain account, every appearance in evaporation may be eaſily deduced. The quantity of heat increaſes evaporation, becauſe it raiſes a greater quantity of ſteam. The quantity of wind increaſes evaporation; for, by waving the ſurface of the water, it thus expoſes a greater ſurface to the evaporating rays. A dry froſt, in ſome meaſure, aſſiſts the quantity of evaporation; as the quantity of rays are found to be no way diminiſhed thereby. Moiſt weather alone prevents evaporation; for the rays being abſorbed, refracted, and broken, by the intervening moiſture, before they arrive at the ſurface, cannot produce the effect; and the vapour will riſe in a ſmall proportion.

Thus far we have accounted for the aſcent of vapours; but to account for their falling again, is attended with rather more difficulty. We have already obſerved, that the particles of vapour, diſengaged from the ſurface of the water, will be broken and attenuated in their aſcent, by the reflected, and even the direct rays, that happen to ſtrike upon their minute ſurfaces. They will, therefore, continue to aſcend, till they riſe above the operation of the reflected rays, which reaches but to a certain height above the ſurface of the earth. Being arrived at this region, which is cold for want of reflected heat, they will be condenſed, and ſuſpended in the form of clouds. Some vapours that aſcend to great heights, will be frozen into ſnow; others, that are condenſed lower down, will put on the appearance of a miſt, which we find the clouds to be, when we aſcend among them, as they hang along the ſides of a mountain. Theſe clouds of ſnow and rain, being blown about by winds, are either entirely ſcattered and diſperſed above, or they are ſtill more condenſed by motion, like a ſnow-ball, that grows more large and ſolid as it continues to roll. At laſt, therefore, they will become too weighty for the air which firſt raiſed them to ſuſtain; and they will deſcend with their exceſs of weight, either in ſnow or rain. But as they will fall precipitately, when they begin to deſcend, the air, in ſome meaſure, will reſiſt the falling; for, as the deſcending fluid gathers velocity in its precipitation, the air will increaſe its reſiſtance to it, and the water will, therefore, be thus broken into rain; as we ſee, that water which falls from the tops of houſes, though it begins in a ſpout, ſeparates into drops before it has got to the bottom. Were it not for this happy interpoſition of the air, between us and the water falling from a conſiderable height above us, a drop of rain might fall with dangerous force, and an hailſtone might ſtrike us with fatal rapidity.

In this manner, evaporation is produced by day; but when the ſun goes down, a part of that vapour which his rays had excited, being no longer broken, and attenuated by the reflecting rays, it will become heavier than the air, even before it has reached the clouds; and it will, therefore, fall back in dews which differ only from rain in deſcending before they have had time to condenſe into a viſible form.

Hail, the Carteſians ſay, is a frozen cloud, half melted, and frozen again in its deſcent. An hoar-froſt is but a frozen dew. Lightning we know to be an electrical flaſh, produced by the oppoſition of two clouds; and thunder to be the ſound proceeding from the ſame, continued by an echo reverberated among them. It would be to very little purpoſe, to attempt explaining exactly how theſe wonders are effected: we have as yet but little inſight into the manner in which theſe meteors are found to operate upon each other; and, therefore, we muſt be contented with a detail rather of their effects than their cauſes.

In our own gentle climate, where Nature wears the mildeſt and kindeſt aſpect, every meteor ſeems to befriend us. With us, rains fall in refreſhing ſhowers, to enliven our fields, and to paint the landſcape with a more vivid beauty. Snows cover the earth, to preſerve its tender vegetables from the inclemency of the departing winter. The dews deſcend with ſuch an imperceptible fall as no way injures the conſtitution. Even thunder itſelf is ſeldom injurious; and it is often wiſhed by the huſbandman, to clear the air, and to kill numberleſs inſects that are noxious to vegetation. Hail is the moſt injurious meteor that is known in our climate; but it ſeldom viſits us with violence, and then its fury is but tranſient,

One of the moſt dreadful ſtorms we hear of*, was that at Hertfordſhire, in the year 1697. It began by thunder and lightning, which continued for ſome hours, when ſuddenly a black cloud came forward, againſt the wind, and marked its paſſage with devaſtation. The hailſtones which it poured down, being meaſured, were found to be many of them fourteen inches round, and conſequently, as large as a bowling-green ball. Wherever it came, every plantation fell before it; it tore up the ground, ſplit great oaks, and other trees, without number; the fields of rye were cut down, as if levelled with a ſcythe; wheat, oats, and barley, ſuffered the ſame damage. The inhabitants found but a precarious ſhelter, even in their houſes, their tiles and windows being broke by the violence of the hailſtones, which, by the force with which they came, ſeemed to have deſcended from a great height. The birds, in this univerſal wreck, vainly tried to eſcape by flight; pigeons, crows, and rooks, and many more of the ſmaller and feebler kinds, were brought down. An unhappy young man, who had not time to take ſhelter, was killed; one of his eyes was ſtruck out of his head, and his body was all over black with the bruiſes: another had juſt time to eſcape, but not without the moſt imminent danger, his body being bruiſed all over. But what is moſt extraordinary, all this fell within the compaſs of a mile.

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* Phil. Tranſ. vol. ii. p. 147.

Mezeray, in his hiſtory of France, tells us of a ſhower of hail much more terrible, which happened in the year 1510, when the French monarch invaded Italy. There was, for a time, an horrid darkneſs, thicker than that of midnight, which continned till the terrors of mankind were changed to ſtill more terrible objects, by thunder and lightning breaking the gloom, and bringing on ſuch a ſhower of hail, as no hiſtory of human calamities could equal. Theſe hailſtones were of a bluiſh colour; and ſome of them weighed not leſs than a hundred pounds. A noiſome vapour of ſulphur attended the ſtorm. All the birds and beaſts of the country were entirely deſtroyed. Numbers of the human race ſuffered the ſame fate. But what it ſtill more extraordinary, the fiſhes found no protection from their native element: but were equal ſufferers in the general calamity.

Theſe, however, are torrors that are ſeldom exerted in our mild climates. They only ſerve to mark the page of hiſtory with wonder; and ſtand as admonitions to mankind, of the various ſtores of puniſhment in the hands of the Deity, which his power can treaſure up, and his mercy can ſuſpend.

In the temperate zones, therefore, meteors are rarely found thus terrible; but between the tropics, and near the poles, they aſſume very dreadful and various appearances. In thoſe inclement regions, where Cold and Heat exert their chief power, meteors ſeem peculiarly to have fixed their reſidence. They are ſeen there in a thouſand terrifying forms, aſtoniſhing to Europeans, yet diſregarded by the natives, from their frequency. The wonders of air, fire, and water, are there combined, to produce the moſt tremendous effects; and to ſport with the labours and apprehenſions of mankind.

Lightnings, that flaſh without noiſe; hurricanes, that tear up the earth; clouds, that all at once pour down their contents, and produce an inſtant deluge; mock ſuns; northern lights, that illuminate half the hemiſphere; circular rainbows; halos; fleeting balls of fire; clouds, reflecting back the images of things on earth, like mirrors; and water-ſpouts, that burſt from the ſea, to join with the miſts that hang immediately above them. Theſe are but a part of the phænomena that are common in thoſe countries; and from many of which, our own climate is, in a great meaſure exempted.

The meteors of the torrid zone, are different from thoſe that are found near the polar circles; and it may readily be ſuppoſed, that in thoſe countries where the ſun exerts the greateſt force in raiſing vapours of all kinds, there ſhould be the greateſt quantity of meteors. Upon the approach of the winter months, as they are called, under the line, which uſually begin about May, the ſky, from a fiery brightneſs, begins to be overcaſt, and the whole horizon ſeems wrapt in a muddy cloud. Miſts and vapours ſtill continue to riſe; and the air, which ſo lately before was clear and elaſtic, now becomes humid, obſcure, and ſtifling: the fogs become ſo thick, that the light of the ſun ſeems in a manner excluded; nor would its preſence be known, but for the intenſe and ſuffocating heat of its beams, which dart through the gloom, and, inſtead of diſſipating, only ſerve to increaſe the miſt. After this preparation, there follows an almoſt continual ſucceſſion of thunder, rain, and tempeſts. During this dreadful ſeaſon, the ſtreets of cities flow like rivers; and the whole country wears the appearance of an ocean. The inhabitants often make uſe of this opportunity to lay in a ſtock of freſh water, for the reſt of the year; as the ſame cauſe which pours down the deluge at one ſeaſon, denies the kindly ſhower at another. The thunder which attends the fall of theſe rains, is much more terrible than that we are generally acquainted with. With us, the flaſh is ſeen at ſome diſtance, and the noiſe ſhortly after enſues; our thunder generally rolls on one quarter of the ſky, and one ſtroke purſues another. But here it is otherwiſe; the whole ſky, ſeems illuminated with unremitted flaſhes of lightning; every part of the air ſeems productive of its own thunders; and every cloud produces its own ſhock. The ſtrokes come ſo thick, that the inhabitants can ſcarce mark the intervals; but all is one unremitted roar of elementary confuſion. It ſhould ſeem, however, that the lightning of thoſe countries is not ſo fatal, or ſo dangerous, as with us; ſince, in this caſe, the torrid zone would be uninhabitable.

When theſe terrors have ceaſed, with which, however, the natives are familiar, meteors of another kind begin to make their appearance. The intenſe beams of the ſun, darting upon ſtagnant waters, that generally cover the ſurface of the country, raiſe vapours of various kinds. Floating bodies of fire, which aſſume different names, rather from their accidental forms, than from any real difference between them, are ſeen without ſurpriſe. The *draco volans*, or flying dragon, as it is called; the *ignis fatuus* or wandering fire; the *fires of St. Helmo*, or the mariner's light, are every where frequent; and of theſe we have numberleſs deſcriptions. "As I was riding in Jamaica," ſays Mr. Barbham, "one morning from my habitation, ſituated about three miles north-weſt from Jago de la Vega, I ſaw a ball of fire, appearing to me of the bigneſs of a bomb, ſwiftly falling down with a great blaze. At firſt I thought it fell into the town; but when I came nearer, I ſaw many people gathered together, a little to the ſouthward, in the Savannah, to whom I rode up, to inquire the cauſe of their meeting: they were admiring, as I found, the ground's being ſtrangely broke up and ploughed by a ball of fire; which, as they ſaid, fell down there. I obſerved there were many holes in the ground; one in the middle of the bigneſs of a man's head, and five or ſix ſmaller round about it, of the bigneſs of one's fiſt, and ſo deep as not to be fathomed by ſuch implements as were at hand. It was obſerved, alſo, that all the green herbage was burnt up, near the holes; and there continued a ſtrong ſmell of ſulphur near the place, for ſome time after."

Ulloa gives an account of one of a ſimilar kind, at Quito*. "About nine at night," ſays he, "a globe of fire appeared to riſe from the ſide of the mountain Pichinca, and ſo large, that it ſpread a light over all the part of the city facing that mountain. The houſe where I lodged, looking that way, I was ſurpriſed with an extraordinary light, darting through the crevices of the window-ſhutters. On this appearance, and the buſtle of the people, in the ſtreet, I haſtened to the window, and came time enough to ſee it, in the middle of its career; which continued from weſt to ſouth, till I loſt ſight of it, being intercepted by a mountain, that lay between me and it. It was round; and its apparent diameter about a foot. I obſerved it to riſe from the ſides of Pichinca; although, to judge from its courſe, it was behind that mountain where this congeries of inflammable matter was kindled. In the firſt half of its viſible it courſe emitted a prodigious effulgence, then it began gradually to grow dim; ſo that, upon its diſappearing behind the intervening mountain, its light was very faint."

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* Ulloa, vol. i. p. 41.

Meteors, of this kind, are very frequently ſeen between the tropics; but they ſometimes, alſo, viſit the more temperate regions of Europe. We have the deſcription of a very extraordinary one, given us by Montanari, that ſerves to ſhew to what great heights, in our atmoſphere, theſe vapours are found to aſcend. In the year 1676, a great globe of fire was ſeen at Bononia, in Italy, about three quarters of an hour after ſun-ſet. It paſſed weſtward, with a moſt rapid courſe, and at the rate of not leſs than a hundred and ſixty miles in a minute, which is much ſwifter than the force of a cannon-ball, and at laſt ſtood over the Adriatic ſea. In its courſe it croſſed over all Italy; and, by computation, it could not have been leſs than thirty-eight miles above the ſurface of the earth. In the whole line of its courſe, wherever it approached, the inhabitants below could diſtinctly hear it, with a hiſſing noiſe, reſembling that of a fire work. Having paſſed away to ſea, towards Corſica, it was heard, at laſt, to go off with a moſt violent exploſion, much louder than that of a cannon; and, immediately after, another noiſe was heard, like the rattling of a great cart, upon a ſtony pavement; which was, probably, nothing more than the echo of the former ſound. Its magnitude, when at Bononia, appeared twice as long as the moon, one way;

and as broad the other; ſo that, conſidering its height, it could not have been leſs than a mile long, and half a mile broad. From the height at which this was ſeen, and there being no volcano, on that quarter of the world, from whence it came, it is more than probable that this terrible globe was kindled on ſome part of the contrary ſide of the globe, in thoſe regions of vapours, which we have been juſt deſcribing; and thus, riſing above the air, and paſſing, in a courſe oppoſite to that of the earth's motion, in this manner it acquired its amazing rapidity.

To theſe meteors, common enough ſouth-ward, we will add one more of a very uncommon kind, which was ſeen, by Ulloa, at Quito, in Peru; the beauty of which will, in ſome meaſure, ſerve to relieve us, after the deſcription of thoſe hideous ones preceding. "At day-break," ſays he, "the whole mountain of Pambamarca, where we then reſided, was encompaſſed with very thick clouds; which the riſing of the ſun diſperſed ſo far, as to leave only ſome vapours, too fine to be ſeen. On the ſide oppoſite to the riſing ſun, and about ten fathoms diſtant from the place where we were ſtanding, we ſaw, as in a looking-glaſs, each his own image; the head being, as it were, the centre of three circular rainbows, one without the other, and juſt near enough to each other as that the colours of the internal verged upon thoſe more external; while round all was a circle of white, but with a greater ſpace between. In this manner theſe circles were erected, like a mirror, before us; and as we moved, they moved, in diſpoſition and order. But, what is moſt remarkable, though we were ſix in number, every one ſaw the phænomenon, with regard to himſelf, and not that relating to others. The diameter of the arches gradually altered, as the ſun roſe above the horizon; and the whole, after continuing a long time, inſenſibly faded away. In the beginning, the diameter of the inward iris, taken from its laſt colour, was about five degrees and a half; and that of the white arch, which ſurrounded the reſt, was not leſs than ſixty-ſeven degrees. At the beginning of the phænomenon, the arches ſeemed of an oval, or eliptical figure, like the diſk of the ſun; and afterwards became perfectly circular. Each of theſe was of a red colour, bordered

bordered with an orange; and the laſt bordered by a bright yellow, which altered into a ſtraw colour, and this turned to a green; but, in all, the external colour remained red." Such is the deſcription of one of the moſt beautiful illuſions that has been ever ſeen in Nature. This alone ſeems to have combined all the ſplendours of optics in one view. To underſtand the manner, therefore, how this phænomenon was produced, would require a perfect knowledge of optics; which it is not our preſent province to enter upon. It will be ſufficient, therefore, only to obſerve, that all theſe appearances ariſe from the denſity of the cloud, together with its uncommon and peculiar ſituation, with reſpect to the ſpectator and the ſun. It may be obſerved, that but one of theſe three rainbows was real, the reſt being only reflections thereof. It may alſo be obſerved, that whenever the ſpectator ſtands between the ſun and a cloud of falling rain, a rainbow is ſeen, which is nothing more than the reflection of the different coloured rays of light from the boſom of the cloud. If, for inſtance, we take a glaſs globe, filled with water, and hang it up before us, oppoſite the ſun, in many ſituations, it will appear tranſparent; but if it is raiſed higher, or ſideways, to an angle of forty-five degrees, it will at firſt appear red; altered a very little higher, yellow; then green, then blue, then violet colour; in ſhort, it will aſſume ſucceſſively all the colours of the rainbow; but, if raiſed higher, ſtill it will become tranſparent again. A falling ſhower may be conſidered as an infinite number of theſe little tranſparent globes, aſſuming different colours, by being placed at the proper heights. The reſt of the ſhower will appear tranſparent, and no part of it will ſeem coloured; but ſuch as are angles of forty-five degrees from the eye, forty-five degrees upward, forty-five degrees on each ſide, and forty-five degrees downward, did not the plane of the earth prevent us. We therefore, ſee only an arch of the rainbow, the lower part being cut off from our ſight by the earth's interpoſition. However, upon the tops of very high mountains, circular rainbows are ſeen, becauſe we can ſee to an angle of forty-five degrees downward, as well as upward, or ſideways, and therefore we take in the rainbow's complete circle.

In thoſe forlorn regions, round the poles, the meteors, though of another kind, are not leſs numerous and alarming.

When the winter begins, and the cold prepares to ſet in, the ſame miſty appearance which is produced in the ſouthern climates by the heat, is there produced by the contrary extreme*. The ſea ſmokes like an oven, and a fog ariſes, which mariners call the *froſt ſmoke*. This cutting miſt commonly raiſes bliſters on ſeveral parts of the body; and, as ſoon as it is wafted to ſome colder part of the atmoſphere, it freezes to little icy particles, which are driven by the wind, and create ſuch an intenſe cold on land, that the limbs of the inhabitants are ſometimes frozen, and drop off.

There, alſo, halos, or luminous circles round the moon, are oftener ſeen than in any other part of the earth, being formed by the froſt ſmoke; although the air otherwiſe ſeems to be clear. A lunar rainbow alſo, is often ſeen there, though ſomewhat different from that which is common with us; as it appears of a pale white, ſtriped with grey. In theſe countries alſo, the aurora borealis ſtreams with peculiar luſtre, and variety of colours. In Greenland it generally ariſes in the eaſt, and darts its ſportive fires, with variegated beauty, over the whole horizon. Its appearance is almoſt conſtant in winter; and, at thoſe ſeaſons when the ſun departs, to return no more for half a year, this meteor kindly riſes to ſupply its beams, and affords ſufficient light for all the purpoſes of exiſtence. However, in the very midſt of their tedious night, the inhabitants are not entirely forſaken. The tops of the mountains are often ſeen painted with the red rays of the ſun; and the poor Greenlander from thence begins to date his chronology. It would appear whimſical to read a Greenland calendar, in which we might be told, That one of their chiefs, having lived forty days, died, at laſt, of a good old age; and that his widow continued for half a day, to deplore his loſs, with great fidelity, before ſhe admitted a ſecond huſband.

The meteors of the day, in theſe countries, are not leſs extraordinary than thoſe of the night: mock ſuns are often reflected upon an oppoſite cloud; and the ignorant ſpectator fancies that there are often three or four real ſuns in the firmament at the ſame time. In this ſplendid appearance the real ſun is always readily known by its ſuperior brightneſs, every reflexion being ſeen with diminiſhed ſplendour. The ſolar rainbow, there is, often ſeen different from ours. Inſtead of a pleaſing variety of colours, it appears of a pale white, edged with a ſtripe of duſky yellow; the whole being reflected from the boſom of a frozen cloud.

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* Paul Egede's Hiſtory of Greenland.

But, of all the meteors which mock the imagination with an appearance of reality, thoſe ſtrange illuſions that are ſeen there, in fine ſerene weather, are the moſt extraordinary and entertaining. "Nothing," ſays Krantz, "ever ſurpriſed me more, than, on a fine warm ſummer's day, to perceive the iſlands that lie four leagues weſt of our ſhore, putting on a form quite different from what they are known to have. As I ſtood gazing upon them, they appeared, at firſt, infinitely greater than what they naturally are; and ſeemed as if I viewed them through a large magnifying glaſs. They were not thus only made larger, but brought nearer to me. I plainly deſcried every ſtone upon the land, and all the furrows filled with ice, as if I ſtood cloſe by. When this illuſion had laſted for a while, the proſpect ſeemed to break up, and a new ſcene of wonder to preſent itſelf. The iſlands ſeemed to travel to the ſhore, and repreſented a wood, or a tall cut hedge. The ſcene then ſhifted, and ſhewed the appearance of all ſorts of curious figures; as ſhips with ſails, ſtreamers and flags; antique elevated caſtles, with decayed turrets; and a thouſand forms, for which fancy found a reſemblance in Nature. When the eye had been ſatisfied with gazing, the whole groupe of riches ſeemed to riſe in air, and at length vaniſh into nothing. At ſuch times the weather is quite ſerene and clear; but compreſſed with ſuch ſubtle vapours, as it is in very hot weather; and theſe appearing between the eye and the object, give it all that variety of appearances which glaſſes of different refrangibilities would have done." Mr. Krantz obſerves, that commonly a couple of hours afterwards, a gentle weſt wind and a viſible miſt follows, which puts an end to this *luſus naturæ*.

It were eaſy to ſwell this catalogue of meteors with the names of many others, both in our own climate and in other parts of the world. Such as falling ſtars, which are thought to be no more than unctuous vapours, raiſed from the earth to ſmall heights, and continuing to ſhine till that matter which firſt raiſed, and ſupported them, being burnt out, they fall back again to the earth, with extinguiſhed flame. Burning ſpears, which are a peculiar kind of aurora borealis; bloody rains, which are ſaid to be the excrements of an inſect, that at that time has been raiſed into the air. Showers of ſtones, fiſhes, and ivy-berries, at firſt, no doubt, raiſed into the air by tempeſts, in one country, and falling at ſome conſiderable diſtance, in the manner of rain, to aſtoniſh another. But omitting theſe, of which we know little more than what is thus briefly mentioned, I will conclude this chapter with the deſcription of a water-ſpout; a moſt ſurpriſing phænomenon; not leſs dreadful to mariners than aſtoniſhing to the obſerver of Nature.

Theſe ſpouts are ſeen very commonly in the tropical ſeas, and ſometimes in our own. Thoſe ſeen by Tournefort, in the Mediterranean, he has deſcribed as follows: "The firſt of theſe," ſay this great botaniſt, "that we ſaw, was about a muſket-ſhot from our ſhip. There we perceived the water began to boil, and to riſe about a foot above its level. The water was agitated and whitiſh; and above its ſurface there ſeemed to ſtand a ſmoke, ſuch as might be imagined to come from wet ſtraw before it begins to blaze. It made a ſort of a murmuring ſound, like that of a torrent, heard at a diſtance, mixed, at the ſame time, with a hiſſing noiſe, like that of a ſerpent: ſhortly after we perceived a column of this ſmoke riſe up to the clouds, as the ſame time whirling about with great rapidity. It appeared to be as thick as one's finger; and the former ſound ſtill continued. When this diſappeared, after laſting for about eight minutes, upon turning to the oppoſite quarter of the ſky, we perceived another, which began in the manner of the former; preſently after a third appeared in the weſt; and inſtantly beſide it ſtill another aroſe. The moſt diſtant of theſe three could not be above a muſket-ſhot from the ſhip. They all continued like ſo many heaps of wet ſtraw ſet on fire, that continued to ſmoke, and to make the ſame noiſe as before. We ſoon after perceived each, with its reſpective canal, mounting up in the clouds, and ſpreading where it touched; the cloud, like the mouth of a trumpet, making a figure, to expreſs it intelligibly, as if the tail of an animal were pulled at one end by a weight

Theſe canals were of a whitiſh colour, and ſo tinged, as I ſuppoſe, by the water which was contained in them; for, previous to this, they were apparently empty, and of the colour of tranſparent glaſs. Theſe canals were not ſtraight, but bent in ſome parts, and far from being perpendicular, but riſing in their clouds with a very inclined aſcent. But what is very particular, the cloud to which one of them was pointed happening to be driven by the wind, the ſpout ſtill continued to follow its motion, without being broken; and paſſing behind one of the others, the ſpouts croſſed each other, in the form of a St. Andrew's croſs. In the beginning they were all about as thick as one's finger, except at the top, where they were broader, and two of them diſappeared; but ſhortly after, the laſt of the three increaſed conſiderably; and its canal, which was at firſt ſo ſmall, ſoon became as thick as a man's arm, then as his leg, and at laſt thicker than his whole body. We ſaw diſtinctly, through this tranſparent body, the water, which roſe up with a kind of ſpiral motion; and it ſometimes diminiſhed a little of its thickneſs, and again reſumed the ſame; ſometimes widening at top, and ſometimes at bottom; exactly reſembling a gut filled with water, preſſed with the fingers, to make the fluid riſe, or fall; and I am well convinced, that this alteration in the ſpout was cauſed by the wind, which preſſed the cloud and impelled it to give up its contents. After ſome time its bulk was ſo diminiſhed as to be no thicker than a man's arm again: and thus, ſwelling and diminiſhing, it at laſt became very ſmall. In the end, I obſerved the ſea which was raiſed about it to reſume its level by degrees, and the end of the canal that touched it to become as ſmall as if it had been tied round with a cord; and this continued till the light, ſtriking through the cloud, took away the view. I ſtill, however, continued to look, expecting that its parts would join again, as I had before ſeen in one of the others, in which the ſpout was more than once broken, and yet again came together; but I was diſappointed, for the ſpout appeared no more."

Many have been the ſolutions offered for this ſurpriſing appearance. Mr. Buffon ſuppoſes the ſpout, here deſcribed, to proceed from the operation of fire, beneath the bed of the ſea; as the waters at the ſurface are thus ſeen agitated. However, the ſolution of Dr. Stuart is not diveſted of probability; who thinks it may be accounted for by ſuction, as in the application of a cupping-glaſs to the ſkin.

Wherever ſpouts of this kind are ſeen they are extremely dreaded by mariners; for if they happen to fall upon a ſhip they moſt commonly daſh it to the bottom. But, if the ſhip be large enough to ſuſtain the deluge, they are at leaſt ſure to deſtroy its ſails and rigging, and render it unfit for ſailing. It is ſaid that veſſels of any force uſually fire their guns at them, loaden with a bar of iron; and, if ſo happy as to ſtrike them, the water is inſtantly ſeen to fall from them, with a dreadful noiſe, though without any further miſchief.

I am at a loſs whether we ought to reckon theſe ſpouts called *typhons*, which are ſometimes ſeen at land, of the ſame kind with thoſe ſo often deſcribed by mariners at ſea, as they ſeem to differ in ſeveral reſpects. That, for inſtance, obſerved at Hatfield, in Yorkſhire, in 1687, as it is deſcribed by the perſon who ſaw it, ſeems rather to have been a whirlwind than a water-ſpout. The ſeaſon in which it appeared was very dry, the weather extremely hot, and the air very cloudy. After the wind had blown for ſome time, with conſiderable force, and condenſed the black clouds one upon another, a great whirling of the air enſued; upon which the centre of the clouds, every now and then, darted down, in the ſhape of a thick long black pipe; in which the relator could diſtinctly view a motion, like that of a ſcrew, continually ſcrewing up to itſelf, as it were, whatever it happened to touch. In its progreſs it moved ſlowly over a grove of young trees, which it violently bent, in a circular motion. Going forward to a barn, it in a minute ſtript it of all the thatch, and filled the whole air with the ſame. As it came near the relator, he perceived that its blackneſs proceeded from a gyration of the clouds, by contrary winds, meeting in a point, or a centre; and where the greateſt force was exerted, there darting down, like an Archimedes's ſcrew, to ſuck up all that came in its way. Another which he ſaw, ſome time after, was attended with ſtill more terrible effects; levelling, or tearing up great oak trees, catching up the birds in its vortex, and daſhing them againſt the ground. In this manner it proceeded, with an audible whirling noiſe, like that of a mill; and, at length, diſſolved, after having done much miſchief.

But we muſt ſtill continue to ſuſpend our aſſent as to the nature even of theſe land ſpouts; ſince they have been ſometimes found to drop, in a great column of water, at once upon the earth, and produce an inſtant inundation*, which could not readily have happened had they been cauſed by the gyration of a whirlwind only. Indeed, every conjecture, regarding theſe meteors, ſeems to me entirely unſatisfactory. They ſometimes appear in the calmeſt weather at ſea, of which I have been an eye-witneſs; and, therefore, theſe are not cauſed by a whirlwind. They are always capped by a cloud; and, therefore, are not likely to proceed from fires at the bottom. They change place; and therefore, ſuction ſeems impracticable. In ſhort, we ſtill want facts, upon which to build a rational theory; and, inſtead of knowledge, we muſt be contented with admiration. To be well acquainted with the appearances of Nature, even though we are ignorant of their cauſes, often conſtitutes the moſt uſeful wiſdom.

CHAP. XXII.

THE CONCLUSION.

HAVING thus gone through a particular deſcription of the earth, let us now pauſe for a moment, to contemplate the great picture before us. The univerſe may be conſidered as the palace in which the Deity reſides; and this earth is one of its apartments. In this, all the meaner races of Animated Nature mechanically obey him; and ſtand ready to execute his commands, without heſitation. Man alone is found refractory; he is the only being endued with a power of contradicting theſe mandates. The Deity was pleaſed to exert ſuperior power in creating him a ſuperior being; a being endued with a choice of good and evil; and capable, in ſome meaſure, of co-operating with his own intentions.

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* Phil. Tranſ. vol. iv. p. 2. 108.

Man, therefore, may be conſidered as a limited creature, endued with powers imitative of thoſe reſiding in the Deity. He is thrown into a world that ſtands in need of his help; and has been granted a power of producing harmony from partial confuſion.

If, therefore, we conſider the earth as allotted for our habitation, we ſhall find, that much has been given us to enjoy, and much to amend; that we have ample reaſons for our gratitude, and ſtill more for our induſtry. In thoſe great outlines of Nature, to which Art cannot reach, and where our greateſt efforts muſt have been ineffectual, God himſelf has finiſhed theſe with amazing grandeur and beauty. Our beneficent Father has conſidered theſe parts of Nature as peculiarly his own; as parts which no creature could have ſkill or ſtrength to amend: and therefore made them incapable of alteration, or of more perfect regularity. The heavens and the firmament ſhew the wiſdom and the glory of the Workman. Aſtronomers, who are beſt ſkilled in the ſymmetry of ſyſtems, can find nothing there that they can alter for the better. God made theſe perfect, becauſe no ſubordinate being could correct their defects.

When, therefore, we ſurvey Nature on this ſide, nothing can be more ſplendid, more correct, or amazing. We there behold a Deity reſiding in the midſt of an univerſe, infinitely extended every way, animating all, and cheering the vacuity with his preſence! We behold an immenſe and ſhapeleſs maſs of matter, formed into worlds by his power, and diſperſed at intervals, to which even the imagination cannot travel! In this great theatre of his glory, a thouſand ſuns, like our own, animate their reſpective ſyſtems, appearing and vaniſhing at Divine command. We behold our own bright luminary fixed in the centre of its ſyſtem, wheeling its planets in times proportioned to their diſtances, and at once diſpenſing light, heat, and action. The earth alſo is ſeen with its twofold motion; producing, by the one, the change of ſeaſons; and, by the other, the grateful viciſſitudes of day and night. With what ſilent magnificence is all this performed! with what ſeeming eaſe! The works of Art are exerted with interrupted force; and their noiſy progreſs diſcovers the obſtructions they receive: but the earth, with a ſilent ſteady rotation, ſucceſſively preſents every part of its boſom to the ſun; at once imbibing nouriſhment and light from that parent of vegetation and fertility.

But not only proviſions of heat and light are thus ſupplied, but its whole ſurface is covered with a tranſparent atmoſphere, that turns with its motion, and guards it from external injury. The rays of the ſun are thus broken into a genial warmth; and, while the ſurface is aſſiſted, a gentle heat is produced in the bowels of the earth, which contributes to cover it with verdure. Waters alſo are ſupplied in healthful abundance, to ſupport life, and aſſiſt vegetation. Mountains ariſe, to diverſify the proſpect, and give a current to the ſtream. Seas extend from one continent to the other, repleniſhed with animals, that may be turned to human ſupport; and alſo ſerving to enrich the earth with a ſufficiency of vapour. Breezes fly along the ſurface of the fields, to promote health and vegetation. The coolneſs of the evening invites to reſt; and the freſhneſs of the morning renews for labour.

Such are the delights of the habitation that has been aſſigned to man! Without any one of theſe, he muſt have been wretched; and none of theſe could his own induſtry have ſupplied. But while many of his wants are thus kindly furniſhed, on the one hand, there are numberleſs inconveniences to excite his induſtry on the other. This habitation, though provided with all the conveniences of air, paſturage, and water, is but a deſert place, without human cultivation. The loweſt animal finds more conveniences in the wilds of Nature, than he who boaſts himſelf their lord. The whirlwind, the inundation, and all the aſperities of the air, are peculiarly terrible to man, who knows their conſequences, and, at a diſtance, dreads their approach. The earth itſelf, where human art has not pervaded, puts on a frightful gloomy appearance. The foreſts are dark and tangled; the meadows overgrown with rank weeds; and the brooks ſtray without a determined channel. Nature, that has been kind to every lower order of beings, has been quite neglectful with regard to him; to the ſavage uncontriving man the earth is an abode of deſolation, where his ſhelter is inſufficient, and his food precarious.

A world thus furniſhed with advantages on one ſide, and inconveniencies on the other, is the proper abode of Reaſon, is the fitteſt to exerciſe the induſtry of a free and a thinking creature. Theſe evils, which Art can remedy, and Preſcience guard againſt, are a proper call for the exertion of his faculties; and they tend ſtill more to aſſimilate him to his Creator. God beholds, with pleaſure, that being which he has made, converting the wretchedneſs of his natural ſituation into a theatre of triumph; bringing all the headlong tribes of Nature into ſubjection to his will; and producing that order and uniformity upon earth, of which his own heavenly fabric is ſo bright an example.

PART II.

OF ANIMALS.

CHAP. I.

A COMPARISON OF ANIMALS WITH THE INFERIOR RANKS OF CREATION.

HAVING given an account of the earth in general, and the advantages and inconveniences with which it abounds, we now come to conſider it more minutely. Having deſcribed the habitation, we are naturally led to inquire after the inhabitants. Amidſt the infinitely different productions which the earth offers, and with with it is every where covered, animals hold the firſt rank; as well becauſe of the finer formation of their parts, as of their ſuperior power. The vegetable, which is fixed to one ſpot, and obliged to wait for its accidental ſupplies of nouriſhment, may be conſidered as the priſoners of Nature. Unable to correct the diſadvantages of its ſituation, or to ſhield itſelf from the dangers that ſurround it, every object that has motion may be its deſtroyer.

But animals are endowed with powers of motion and defence. The greateſt part are capable, by changing place, of commanding Nature; and of thus obliging her to furniſh that nouriſhment which is moſt agreeable to their ſtate. Thoſe few that are fixed on one ſpot, even in this ſeemingly helpleſs ſituation, are, nevertheleſs, protected from external injury, by an hard ſhelly covering; which they often can cloſe at pleaſure, and thus defend themſelves from every aſſault. And here, I think, we may draw the line between the animal and vegetable kingdoms. Every animal, by ſome means or other, finds protection from injury; either from its force, or courage, its ſwiftneſs, or cunning. Some are protected by hiding in convenient places; and others by taking refuge in an hard reſiſting ſhell. But vegetables are totally unprotected; they are expoſed to every aſſailant, and patiently ſubmiſſive in every attack. In a word, an animal is an organized being that is in ſome meaſure provided for its own ſecurity; a vegetable is deſtitute of every protection.

But though it is very eaſy, without the help of definitions, to diſtinguiſh a plant from an animal, yet both poſſeſs many properties ſo much alike, that the two kingdoms, as they are called, ſeem mixed with each other. Hence, it frequently puzzles the naturaliſt to tell exactly where animal life begins, and vegetative terminates; nor indeed is it eaſy to reſolve, whether ſome objects offered to view be of the loweſt of the animal, or the higheſt of the vegetable, race. The ſenſitive plant, that moves at the touch, ſeems to have as much perception as the freſh-water polypus, that is poſſeſſed of a ſtill ſlower ſhare of motion. Beſides, the ſenſitive plant will not reproduce upon cutting in pieces, which the polypus is known to do; ſo that the vegetable production ſeems to have the ſuperiority. But, notwithſtanding this, the polypus hunts for its food, as moſt other animals do. It changes its ſituation; and, therefore, poſſeſſes a power of chooſing its food, or retreating from danger. Still, therefore, the animal kingdom is far removed above the vegetable; and its loweſt denizen is poſſeſſed of very great privileges, when compared with the plants with which it is often ſurrounded.

However, both claſſes have many reſemblances, by which they are raiſed above the unorganized and inert maſſes of Nature. Minerals are mere inactive, inſenſible bodies, entirely motionleſs of themſelves, and waiting ſome external force to alter their forms, or their properties. But it is otherwiſe with animals and vegetables; theſe are endued with life and vigour; they have their ſtate of improvement and decay; they are capable of reproducing their kinds; they grow from ſeeds, in ſome, and from cuttings in others;

they ſeem all poſſeſſed of ſenſation, in a greater or leſs degree; they both have their enmities and affections; and and as ſome animals are, by nature, impelled to violence, ſo ſome plants are found to exterminate all others, and make a wilderneſs of the places round them. As the lion makes a deſert of the foreſt where it reſides, thus no other plant will grow under the ſhade of the machinel-tree. Thus, alſo, that plant, in the Weſt-Indies, called *caraguata*, clings round whatever tree it happens to approach: there it quickly gains the aſcendant; and loading the tree with a verdure not its own, keeps away that nouriſhment deſigned to feed the trunk; and, at laſt, entirely deſtroys its ſupporter. As all animals are ultimately ſupported upon vegetables, ſo vegetables are greatly propagated, by being made a part of animal food. Birds deſtribute the ſeeds wherever they fly, and quadrupeds prune them into greater luxuriance. By theſe means the quantity of food, in a ſtate of nature, is kept equal to the number of the conſumers; and, leſt ſome of the weaker ranks of animals ſhould find nothing for their ſupport, but all the proviſions be devoured by the ſtrong, different vegetables are appropriated to different appetites. If, tranſgreſſing this rule, the ſtronger ranks ſhould invade the rights of the weak, and, breaking through all regard to appetite, ſhould make an indiſcriminate uſe of every vegetable, Nature then puniſhes the tranſgreſſion, and poiſon marks the crime as capital.

If again we compare vegetables and animals, with reſpect to the places where they are found, we ſhall find them bearing a ſtill ſtronger ſimilitude. The vegetables that grow in a dry and ſunny ſoil, are ſtrong and vigorous, though not luxuriant; ſo alſo are the animals of ſuch a climate. Thoſe, on the contrary, that are the joint product of heat and moiſture, are luxuriant and tender: and the animals aſſimilating to the vegetable food, on which they ultimately ſubſiſt, are much larger in ſuch places than in others. Thus, in the internal parts of South America, and Africa, where the ſun uſually ſcorches all above, while inundations cover all below, the inſects, reptiles, and other animals, grow to a prodigious ſize: the earth-worm of America is often a yard in length, and as thick as a walking cane; the boiguacu, which is the largeſt of the ſerpent kind, is ſometimes forty feet in length; the bats, in thoſe countries, are as big as a rabbit; the toads are bigger than a duck, and their ſpiders are as large as a ſparrow. On the contrary, in the cold frozen regions of the north, where vegetable nature is ſtinted of its growth, the few animals in thoſe climates partake of the diminution; all the wild animals, except the bear, are much ſmaller than in milder countries; and ſuch of the domeſtic kinds as are carried thither, quickly degenerate, and grow leſs. Their very inſects are of the minute kinds, their bees and ſpiders being not half ſo large as thoſe in the temperate zone.

The ſimilitude between vegetables and animals is no where more obvious than in thoſe that belong to the ocean, where the nature of one is admirably adapted to the neceſſities of the other. This element it is well known has its vegetables, and its inſects that feed upon them in great abundance. Over many tracts of the ſea, a weed is ſeen floating, which covers the ſurface, and gives the reſemblance of a green and extenſive meadow. On the under ſide of theſe unſtable plants, millions of little animals are found, adapted to their ſituation. For as their ground, if I may ſo expreſs it, lies over their heads, their feet are placed upon their backs; and as land animals have their legs below their bodies, theſe have them above. At land alſo, moſt animals are furniſhed with eyes to ſee their food; but at ſea, almoſt all the reptile kinds are without eyes, which might only give them proſpects of danger, at a time when unprovided with the means of eſcaping it*.

Thus, in all places, we perceive an obvious ſimilitude between the animals and the vegetables of every region. In general, however, the moſt perfect races have the leaſt ſimilitude to the vegetable productions on which they are ultimately fed; while, on the contrary, the meaner the animal, the more local it is found to be, and the more it is influenced by the varieties of the ſoil where is reſides. Many of the more humble reptile kinds are not only confined to one country, but alſo to a plant; nay, even to a leaf. Upon that they ſubſiſt; increaſe with its vegetation, and ſeem to decay as it declines. They are merely the circumſcribed inhabitants of a ſingle vegetable; take them from that and they inſtantly die; being; entirely aſſimilated to the plant they feed on, aſſuming its colour, and even its medicinal properties. For this reaſon there are infinite numbers of the meaner animals that we have never an opportunity of ſeeing in this part of the world; they are incapable of living ſeparate from their kindred vegetables, which grow only in a certain climate.

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* Linnæi Amenitates, vol. v. p. 68.

Such animals as are formed more perfect, lead a life of leſs dependence; and, ſome kinds are found to ſubſiſt in many parts of the world at the ſame time. But, of all the races of Animated Nature, man is the leaſt affected by the ſoil where he reſides, and leaſt influenced by the variations of vegetable ſuſtenance: equally unaffected by the luxuriance of the warm climates, or the ſterility of the poles, he has ſpread his habitations over the whole earth; and finds ſubſiſtence as well amidſt the ice of the north as the burning deſerts under the line. All creatures of an inferior nature, as has been ſaid, have peculiar propenſities to peculiar climates; they are circumſcribed to zones, and confined to territories where their proper food is found in the greateſt abundance; but, man may be called the animal of every climate, and ſuffers but very gradual alterations from the nature of any ſituation.

As to animals of a meaner rank, whom man compels to attend him in the migrations, theſe being obliged to live in a kind of conſtraint and upon vegetable food, often different from that of their native ſoil, they very ſoon alter their natures with the nature of their nouriſhment, aſſimilate to the vegetables upon which they are fed, and thus aſſume very different habits as well as appearances. Thus, man, unaffected himſelf, alters and directs the nature of other animals at his pleaſure; increaſes their ſtrength for his delight, or their patience for his neceſſities.

This power of altering the appearances of things, ſeems to have been given him for very wiſe purpoſes. The Deity, when he made the earth, was willing to give his favoured creature many opponents, that might at once exerciſe his virtues, and call forth his latent abilities. Hence we find, in thoſe wide uncultivated wilderneſſes, where man, in his ſavage ſtate, owns inferior ſtrength, and the beaſts claim divided dominion, that the whole foreſt ſwarms with noxious animals and vegetables; animals, as yet undeſcribed, and vegetables which want a name. In thoſe receſſes, Nature ſeems rather laviſh than magnificent, in beſtowing life. The trees are uſually of the largeſt kinds, covered round with paraſite plants, and interwoven at the tops with each other. The boughs, both above and below, are peopled with various generations; ſome of which have never been upon the ground, and others have never ſtirred from the branches on which they were produced. In this manner millions of minute, and loathſome creatures, purſue a round of uninterrupted exiſtence, and enjoy a life ſcarce ſuperior to vegetation. At the ſame time, the vegetables, in thoſe places, are of the larger kinds, while the animal race is of the ſmaller: but, man has altered this diſpoſition of Nature; having, in a great meaſure, levelled the extenſive foreſts, cultivated the ſofter and finer vegetables, deſtroyed the numberleſs tribes of minute and noxious animals, and taken every method to increaſe a numerous breed of the larger kinds. He thus has exerciſed a ſevere control; unpeopled Nature, to embelliſh it; and diminiſhed the ſize of vegetable, in order to improve that of the animal kingdom.

To ſubdue the earth to his own uſe, was, and ought to be, the aim of man; which was only to be done by encreaſing the number of plants, and diminiſhing that of animals: to multiply exiſtence, *alone* was that of the Deity. For this reaſon, we find, in a ſtate of nature, that animal life is increaſed to the greateſt quantity poſſible: and, we can ſcarce form a ſyſtem that could add to its numbers. Firſt, plants, or trees, are provided, by Nature, of the largeſt kinds; and, conſequently, the nouriſhing ſurface is thus extended. In the ſecond place, there are animals peculiar to every part of the vegetable, ſo that no part of it is loſt. But, the greateſt poſſible increaſe of life would ſtill be deficient, were there not other animals that lived upon animals; and theſe are, themſelves, in turn, food for ſome other greater and ſtronger ſet of creatures. Were all animals to live upon vegetables alone, thouſands would be extinct that now have exiſtence, as the quantity of their proviſion would ſhortly fail. But, as things are wiſely conſtituted, one animal now ſupports another; and thus, all take up leſs room than they would by living on the ſame food; as, to make uſe of a ſimilar inſtance, a greater number of people may be crowded into the ſame ſpace, if each is made to bear his fellow upon his ſhoulders.

To diminiſh the number of animals, and increaſe that of vegetables, has been the general ſcope of human induſtry; and, if we compare the utility of the kinds, with reſpect to man, we ſhall find, that of the vaſt variety in the animal kingdom, but very few are ſerviceable to him; and, in the vegetable, but very few are entirely noxious. How ſmall a part of the inſect tribes, for inſtance, are beneficial to mankind, and what numbers are injurious! In ſome countries they almoſt darken the air: a candle cannot be lighted without their inſtantly flying upon it, and putting out the flame*. The cloſeſt receſſes are no ſafeguard from their annoyance; and the moſt beautiful landſcapes of Nature only ſerve to invite their rapacity. As theſe are injurious, from their multitudes, ſo moſt of the larger kinds are equally dreadful to him, from their courage and ferocity. In the moſt uncultivated parts of the foreſt theſe maintain an undiſputed empire; and man invades their retreats with terror. Theſe are terrible; and there are ſtill more that are utterly uſeleſs to him, that ſerve to take up the room which more beneficial creatures might poſſeſs; and incommode him rather with their numbers than their enmities. Thus, in a catalogue of land animals, that amounts to more than twenty thouſand, we can ſcarcely reckon up an hundred that are any way uſeful to him; the reſt, being either all his open, or his ſecret enemies, immediately attacking him in perſon, or intruding upon that food he has appropriated to himſelf. Vegetables, on the contrary, though exiſting in greater variety, are but few of them noxious. The moſt deadly poiſons are often of great uſe in medicine; and even thoſe plants that only ſeem to cumber the ground, ſerve for food to that race of animals which he has taken into friendſhip, or protection. The ſmaller tribes of vegetables, in particular, are cultivated, as contributing either to his neceſſities, or amuſement; ſo that vegetable life is as much promoted, by human induſtry, as animal life is controlled and diminiſhed.

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* Ulloa's Deſcription of Guyaquil.

Hence, it was not without a long ſtruggle, and various combinations, of experience and art, that man acquired his preſent dominion. Almoſt every good that he poſſeſſes was the reſult of the conteſt; for, every day, as he was contending, he was growing more wiſe; and patience and fortitude were the fruits of his induſtry.

From hence, alſo, we ſee the neceſſity of ſome animals living upon each other, to fill up the plan of Providence; and we may, conſequently, infer the expediency of man's living upon all. Both animals and vegetables ſeem equally fitted to his appetites; and, were any religious, or moral motives, to reſtrain him from taking away life, upon any account, he would only thus give exiſtence to a variety of beings made to prey upon each other; and, inſtead of preventing, multiply mutual deſtruction.

CHAP. II.

OF THE GENERATION OF ANIMALS.

BEFORE we ſurvey animals in their ſtate of maturity, and performing the functions adapted to their reſpective natures, method requires that we ſhould conſider them in the more early periods of their exiſtence. There has been a time when the proudeſt and the nobleſt animal was a partaker of the ſame imbelicity with the meaneſt reptile; and, while yet a candidate for exiſtence, equally helpleſs and contemptible. In their incipient ſtate all are upon a footing; the inſect and the philoſopher being equally inſenſible, clogged with matter, and unconſcious of exiſtence. Where then are we to begin with the hiſtory of thoſe beings, that make ſuch a diſtinguiſhed figure in the creation? Or, where lie thoſe peculiar characters in the parts that go to make up Animated Nature—that mark one animal as deſtined to creep in the duſt, and another to glitter on the throne?

This has been a ſubject that has employed the curioſity of all ages, and the philoſophers of every age have attempted the ſolution. In tracing Nature to her moſt hidden receſſes, ſhe becomes too minute, or obſcure, for our inſpection; ſo that we find it impoſſible to mark her firſt differences, to diſcover the point where animal life begins, or the cauſe that conduces to ſet it in motion. We know little more than that the greateſt number of animals require the concurrence of a male and female to reproduce their kind; and that theſe, diſtinctly and invariably, are found to beget creatures of their own ſpecies. Curioſity has, therefore, been active, in trying to diſcover the immediate reſult of this union; how far either ſex contributes to the beſtowing animal life, and whether it be to the male or female that we are moſt indebted for the privilege of our exiſtence.

Hippocrates has ſuppoſed that fecundity proceeded from the mixture of the ſeminal liquor of both ſexes, each of which equally contribute to the formation of the incipient animal. Ariſtotle, on the other hand, would have the ſeminal liquor in the male alone to contribute to this purpoſe, while the female ſupplied the proper nouriſhment for its ſupport. Such were the opinions of theſe Fathers of Philoſophy; and theſe continued to be adopted by the naturaliſts, and ſchoolmen, of ſucceeding ages, with blind veneration. At length, Steno and Harvey, taking anatomy for their guide, gave mankind a nearer view of Nature juſt advancing into animation. Theſe perceived in all ſuch animals as produced their young alive, two glandular bodies, near the womb, reſembling that ovary, or cluſter of ſmall eggs, which is found in fowls; and, from the analogy between both, they gave theſe alſo the name of ovaria. Theſe, as they reſembled eggs, they naturally concluded had the ſame offices; and, therefore, they were induced to think that all animals, of what kind ſoever, were produced from eggs. At firſt, however, there was ſome altercations raiſed againſt this ſyſtem: for, as theſe ovaria were ſeparate from the womb, it was objected that they could not be any way inſtrumental in repleniſhing that organ, with which they did not communicate. But, upon more minute inſpection, Fallopius, the anatomiſt, perceived two tubular veſſels depending from the womb, which, like the horns of a ſnail, had a power of erecting themſelves, of embracing the ovaria, and of receiving the eggs, in order to be fecundated by the ſeminal liquor. This diſcovery ſeemed, for a long time after to fix the opinions of philoſophers. The doctrine of Hippocrates was re-eſtabliſhed, and the chief buſineſs of generation was aſcribed to the female. This was, for a long time the eſtabliſhed opinion of the ſchools; but Leuwenhoeck, once more, ſhook the whole ſyſtem, and produced a new ſchiſm among the lovers of ſpeculation. Upon examining the ſeminal liquor, of a great variety of male animals, with microſcopes, which helped his ſight more than that of any of his ſucceſſors, he perceived therein infinite numbers of little living creatures, like tadpoles, very briſk, and floating in the fluid, with a ſeeming voluntary motion. Each of theſe, therefore, was thought to be the rudiments of an animal, ſimilar to that from which it was produced; and this only required a reception from the female, together with proper nouriſhment, to complete its growth. The buſineſs of generation was now, therefore, given back to the male a ſecond time, by many; while others ſuſpended their aſſent, and choſe rather to confeſs ignorance than to embrace error *.

In this manner has the diſpute continued for ſeveral ages, ſome accidental diſcovery ſerving, at intervals, to renew the debate, and revive curioſity. It was a ſubject where ſpeculation could find much room to diſplay itſelf; and, Mr. Buffon, who loved to ſpeculate, would not omit ſuch an opportunity of giving ſcope to his propenſity. According to this moſt pleaſing of all naturaliſts, the microſcope diſcovers that the ſeminal liquor, not only of males, but of females alſo, abounds in theſe moving little animals, which have been mentioned above, and that they appear equally briſk in either fluid. Theſe he takes not to be real animals, but organical particles, which, being ſimple, cannot be ſaid to be organized themſelves, but go to the compoſition of all organized bodies whatſoever. In the ſame manner as a tooth, in the wheel of a watch, cannot be called either the wheel, or the watch, and yet contributes to the ſum of the machine. Theſe organical particles are, according to him, diffuſed throughout all Nature, and to be found not only in the ſeminal liquor, but in moſt other fluids in the parts of vegetables, and all parts of Animated Nature. As they happen, there-

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* Bonet Conſiderations ſur les Corps Organiſés.

fore; to be differently applied, they ſerve to conſtitute a part of the animal, or the vegetable, whoſe growth they ſerve to increaſe, while the ſuperfluity is thrown off in the ſeminal liquor of both ſexes, for the reproduction of other animals or vegetables of the ſame ſpecies. Theſe particles aſſume different figures, according to the receptacle into which they enter; falling into the womb they unite into a fœtus; beneath the bark of a tree they pullulate into branches; and, in ſhort, the ſame particles that firſt formed the animal in the womb, contribute to increaſe its growth when brought forth*.

To this ſyſtem it has been objected, that it is impoſſible to conceive organical ſubſtances without being organized; and that, if diveſted of organization themſelves, they could never make an organized body, as an infinity of circles could never make a triangle. It has been objected, that it is more difficult to conceive the transformation of theſe organical particles, than even that of the animal, whoſe growth we are inquiring after; and this ſyſtem, therefore, attempts to explain one obſcure thing by another ſtill more obſcure.

But an objection, ſtill ſtronger than theſe, has been advanced, by an ingenious countryman of our own; who aſſerts, that theſe little animals, which thus appear ſwimming, and ſporting, in almoſt every fluid we examine with a microſcope, are not real living particles, but ſome of the more opake parts of the fluid, that are thus increaſed in ſize, and ſeem to have a much greater motion than they have in reality. For the motion being magnified with the object, the ſmalleſt degree of it will ſeem very conſiderable; and a being almoſt at reſt may, by theſe means, be apparently put into violent action. Thus, for inſtance, if we look upon the ſails of a windmill moving, at a diſtance, they appear to go very ſlow; but, if we approach them, and thus magnify their bulk to our eye, they go round with great rapidity. A microſcope, in the ſame manner, ſerves to bring our eye cloſe to the object, and thus to enlarge it; and not only increaſe the magnitude of its parts, but of its motion. Hence, therefore, it would follow, that theſe organical particles that are ſaid to conſtitute the bulk of living nature, are but mere optical illuſions; and the ſyſtem founded on them muſt, like them, be illuſive.

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* Mr. Buffon.

Theſe, and many other objections, have been made to this ſyſtem; which, inſtead of enlightening the mind, ſerve only to ſhew, that too cloſe a purſuit of Nature very often leads to uncertainty. Happily, however, for mankind, the moſt intricate inquiries are generally the moſt uſeleſs. Inſtead, therefore, of balancing accounts between the ſexes, and attempting to aſcertain to which the buſineſs of generation moſt properly belongs, it will be more inſtructive, as well as amuſing, to begin with Animal Nature, from its earlieſt retirements, and evaneſcent outlines, and purſue the incipient creature through all its changes in the womb, till it arrives into open day.

The uſual diſtinction of animals, with reſpect to their manner of generation, has been into the Oviparous and Viviparous kinds; or, in other words, into thoſe that bring an egg, which afterwards hatched into life, and thoſe that bring forth their young alive and perfect. In one of theſe two ways all animals were ſuppoſed to have been produced, and all other kinds of generation were ſuppoſed imaginary or erroneous. But later diſcoveries have taught us to be more cautious in making general concluſions, and have even induced many to doubt whether animal life may not be produced merely from putrefaction*.

Indeed, the infinite number of creatures that putrid ſubſtances ſeem to give birth to, and the variety of little inſects ſeen floating in liquors, by the microſcope, appear to favour, this opinion. But, however this may be, the former method of claſſing animals can now by no means be admitted, as we find many animals that are produced neither from the womb, nor from the ſhell, but merely from cuttings; ſo that to multiply life in ſome creatures, it is ſufficient only to multiply the diſſection. This being the ſimpleſt method of generation, and that in which life ſeems to require the ſmalleſt preparation for its exiſtence, I will begin with it, and ſo proceed to the two other kinds, from the meaneſt to the moſt elaborate.

The earth-worm, the millipedes, the ſea-worm, and many marine inſects, may be multiplied by being cut in pieces;

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* Bonet Conſid. p. 100.

but the polypus is noted for its amazing fertility; and from hence it will be proper to take the deſcription. The ſtructure of the polypus may be compared to the finger of a glove, open at one end, and cloſed at the other. The cloſed end repreſents the tail of the polypus, with which it ſerves to fix itſelf to any ſubſtance it happens to be upon; the open end may be compared to the mouth; and, if we conceive ſix or eight ſmall ſtrings iſſuing from this end, we ſhall have a proper idea of its arms, which it can erect, lengthen, and contract, at pleaſure, like the horns of a ſnail. This creature is very voracious, and makes uſe of its arms as a fiſherman does of his net, to catch and entangle ſuch little animals as happen to come within its reach. It lengthens theſe arms ſeveral inches, keeps them ſeparated from each other, and thus occupies a large ſpace in the water, in which it reſides. Theſe arms, when extended, are as fine as threads of ſilk, and have a moſt exquiſite degree of feeling. If a ſmall worm happens to get within the ſphere of their activity, it is quickly entangled by one of theſe arms, and, ſoon after, the other arms come to its aid: theſe altogether ſhortening, the worm is drawn into the animal's mouth, and quickly devoured, colouring the body as it is ſwallowed. Thus much is neceſſary to be obſerved of this animal's method of living, to ſhew that it is not of the vegetable tribe, but a real animal, performing the functions which other animals are found to perform, and endued with powers that many of them are deſtitute of. But what is moſt extraordinary remains yet to be told; for, if examined with a microſcope, there are ſeen ſeveral little ſpecks, like buds, that ſeem to pollulate from different parts of its body; and theſe, ſoon after appear to be young polypi and like the large polypus, begin to caſt their little arms about for prey, in the ſame manner. Whatever they happen to inſnare is devoured, and gives a colour not only to their own bodies, but to that of the parent; ſo that the ſame food is digeſted, and ſerves for the nouriſhment of both. The food of the little one paſſes into the large polypus, and colours its body; and this, in its turn, digeſts, and ſwallows its food to paſs into theirs. In this manner every polypus has a new colony ſprouting from its body; and theſe new ones, even while attached to the parent animal, become parents themſelves, having a ſmaller colony alſo budding from them: All, at the ſame time, buſily employed in ſeeking for their prey, and the food of any one of them ſerving for the nouriſhment, and circulating through the bodies of all the reſt. This ſociety, however, is every hour diſſolving; thoſe newly produced are ſeen at intervals to leave the body of the large polypus, and become, ſhortly after, the head of a beginning colony themſelves.

In this manner the polypus multiplies naturally; but, one may take a much readier and ſhorter way to increaſe them, and this only by cutting them in pieces. Though cut into thouſands of parts, each part ſtill retains its vivacious quality, and each ſhortly becomes a diſtinct and a complete polypus; whether cut lengthwiſe, or croſswiſe, it is all the ſame; this extraordinary creature ſeems a gainer by our endeavours, and multiplies by apparent deſtruction. The experiment had been tried, times without number, and ſtill attended with the ſame ſucceſs. Here, therefore, naturaliſts who have been blamed for the cruelty of their experiments upon living animals, may now boaſt of their increaſing animal life, inſtead of deſtroying it. The production of the polypus is a kind of philoſophical generation. The famous Sir Thomas Brown hoped one day to be able to produce children by the ſame method as tree are produced; the polypus is multiplied in this manner; and every philoſopher may thus, if he pleaſes, boaſt of a very numerous, though, I ſhould ſuppoſe, a very uſeleſs progeny.

This method of generation, from cuttings, may be conſidered as the moſt ſimple kind, and is a ſtrong inſtance of the little pains Nature takes in the formation of her lower, and humbler productions. As the removal of theſe from inanimate into animal exiſtence is but ſmall, there are but few preperations made for their journey. No organs of generation ſeem provided, no womb to receive, no ſhell to protect them in their ſtate of tranſition. The little reptile is quickly fitted for all the offices of its humble ſphere, and, in a very ſhort time, arrives at the height of its contemptible perfection,

The next generation is of thoſe animals that we ſee produced from the egg. In this manner all birds, moſt fiſhes, and many of the inſect tribes, are brought forth. An egg may be conſidered as a womb, detached from the body of the parent animal, in which the embryo is but juſt beginning to be formed. It may be regarded as kind of incomplete delivery, in which the animal is diſburthened of its young before its perfect formation. Fiſhes and inſects, indeed, moſt uſually commit the care of their eggs to hazard; but birds, which are more perfectly formed, are found to hatch them into maturity, by the warmth of their bodies. However, any other heat, of the ſame temperature, would anſwer the end as well; for either the warmth of the ſun, or of a ſtove, is equally efficacious in bringing the animal in the egg to perfection. In this reſpect, therefore, we may conſider generation from the egg as inferior to that in which the animal is brought forth alive. Nature has taken care of the viviparous animal in every ſtage of its exiſtence. That force which ſeparates it from the parent, ſeparates it from life; and the embryo is ſhielded with unceaſing protection till it arrives at excluſion. But it is different with the little animal in the egg; often totally neglected by the parent, and always ſeparable from it, every accident may retard its growth, or even deſtroy its exiſtence. Beſides, art, or accident, alſo, may bring this animal to a ſtate of perfection; ſo that it can never be conſidered as a complete work of Nature, in which ſo much is left for accident to finiſh or deſtroy.

But, however inferior this kind of generation may be, the obſervation of it will afford great inſight into that of nobler animals, as we can here watch the progreſs of the growing embryo, in every period of its exiſtence, and catch it in thoſe very moments when it firſt ſeems ſtealing into motion. Malpighi and Haller have been particularly induſtrious on this ſubject; and, with a patience almoſt equalling that of the ſitting hen, have attended incubation in all its ſtages. From them, therefore, we have an amazing hiſtory of the chicken in the egg, and of its advances into complete formation.

It would be methodically tedious to deſcribe thoſe parts of the egg, which are well known, and obvious; ſuch as its ſhell, its white, and its yolk; but the diſpoſition of theſe is not ſo apparent. Immediately under the ſhell lies that common membrane, or ſkin, which lines it on the inſide, adhering cloſely to it every where, except at the broad end, where a little cavity is left, that is filled with air, which increaſes as the animal within grows larger. Under this membrane are contained two whites, though ſeeming to us to be only one, each wrapped up in a membrane of its own, one white within the other. In the midſt of all is the yolk, wrapt round, likewiſe, in its own membrane. At each end of this are two ligaments, called *chalazæ,* which are, as it were, the poles of this microcoſm, being white denſe ſubſtances, made from the membranes, and ſerving to keep the white and the yolk in their places. It was the opinion of Mr. Derham that they ſerved alſo for another purpoſe: for a line being drawn from one ligament to the other, would not paſs directly through the middle of the yolk, but rather towards one ſide, and would divide the yolk into two unequal parts, by which means theſe ligaments ſerved to keep the ſmalleſt ſide of the yolk always uppermoſt; and in this part he ſuppoſed the cicatricula or firſt ſpeck of life, to reſide; which, by being uppermoſt, and conſequently next the hen, would be thus in the warmeſt ſituation. But this is rather fanciful than true, the incipient animal being found in all ſituations, and not particularly influenced by any*. This cicatricula, which is the part where the animal firſt begins to ſhew ſigns of life, is not unlike a vetch, or a lentil, lying on one ſide of the yolk, and within its membrane. All theſe contribute to the little animal's convenience, or ſupport; the outer membranes, and ligaments, preſerve the fluids in their proper places; the white ſerves as nouriſhment; and the yolk, with its membranes, after a time, becomes a part of the animal's body†. This is the deſcription of an hen's egg, and anſwers to that of all others, how large or how ſmall ſoever.

Previous to putting the eggs to the hen, our philoſophers firſt examined the cicatricula, or little ſpot, already mentioned; and which may be conſidered as the moſt important part of the egg. This was found, in thoſe that were impregnated by the cock, to be large; but, in thoſe laid without the cock, very ſmall. It was found, by the microſcope, to be a kind of bag, containing a tranſparent liquor, in the midſt of which the embryo was ſeen to reſide. The embryo reſembled a compoſition of little threads, which the warmth of future incubation tended to enlarge, by varying, and liquifying the other fluids contained within the ſhell, and thus preſſing them either into the pores or tubes of their ſubſtance.

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* Haller. † Ibid.

Upon placing the eggs in a proper warmth*, either under the ſun, or in a ſtove, after ſix hours the vital ſpeck begins to dilate, like the pupil of the eye. The head of the chicken is diſtinctly ſeen, with the back bone, ſomething reſembling a tadpole, floating in its ambient fluid, but as yet ſeeming to aſſume none of the functions of animal life. In about ſix hours more the little animal is ſeen more diſtinctly; the head becomes more plainly viſible, and the vertebræ of the back more eaſily perceivable. All theſe ſigns of preparation for life are increaſed in ſix hours more; and, at the end of twenty-four hours, the ribs begin to take their places, the neck begins to lengthen, and the head to turn to one ſide.

At this time†, alſo, the fluids in the egg ſeem to have changed place; the yolk, which was before in the centre of the ſhell, approaches nearer to the broad end. The watery part of the white is, in ſome meaſure evaporated through the ſhell, and the groſſer part ſinks to the ſmall end. The little animal appears to turn towards the part of the broad end, in which a cavity has been deſcribed, and with its yolk ſeems to adhere to the membrane there. At the end of forty hours the great work of life ſeems fairly begun, and the animal plainly appears to move; the back-bone, which is of a whitiſh colour, thickens; the head is turned ſtill more on one ſide; the firſt rudiments of the eyes begin to appear; the heart beats, and the blood begins already to circulate. The parts, however, as yet are fluid; but, by degrees, become more and more tenacious, and harden into a kind of jelly. At the end of two days, the liquor in which the chicken ſwims, ſeem to increaſe; the head appears with two little bladders in the place of eyes, the heart beats in the manner of every embryo where the blood does not circulate through the lungs. In about fourteen hours after this, the chicken is grown more ſtrong; its head, however, is ſtill bent downwards; the veins and the arteries begin to branch, in order to form the brain; and the ſpinal marrow is ſeen ſtretching along the back bone. In three days, the whole body of the chicken appears bent; the head, with its two eye-balls, with their different humours, now diſtinctly appear; and five other veſicles are ſeen, which ſoon unite to form the rudiments of the brain. The outlines alſo of the thighs, and wings, begin to be ſeen, and the body begins to gather fleſh. At the end of the fourth day, the veſicles that go to form the brain, approach each other; the wings and thighs appear more ſolid; the whole body is covered with a jelly like fleſh; the heart, that was hitherto expoſed, is now covered up within the body, by a very thin tranſparent membrane; and, at the ſame time, the umbilical veſſels, that unite the animal to the yolk, now appear to come forth from the abdomen. After the fifth and ſixth days, the veſſels of the brain begin to be covered over; the wings and thighs lengthen; the belly is cloſed up, and tumid; the liver is ſeen within it, very diſtinctly, not yet grown red, but of a very duſky white; both the ventricles of the heart are diſcerned, as if they were two ſeparate hearts, beating diſtinctly; the whole body of the animal is covered over; and the traces of the incipient feathers are already to be ſeen. The ſeventh day, the head appears very large; the brain is covered entirely over; the bill begins to appear betwixt the eyes; and the wings, the thighs, and the legs, have acquired their perfect figure*. Hitherto, however, the animal appears as if it had two bodies; the yolk is joined to it by the umbilical veſſels that come from the belly; and is furniſhed with its veſſels, through which the blood circulates, as through the reſt of the body of the chicken, making a bulk greater than that of the animal itſelf. But towards the end of incubation, the umbilical veſſels ſhorten the yolk, and with it the inteſtines are thruſt up into the body of the chicken, by the action of the muſcles of the belly; and the two bodies are thus formed into one. During this ſtate, all the organs are found to perform their ſecretions; the bile is found to be ſeparated, as in grown animals; but it is a fluid, tranſparent, and without bitterneſs: and the chicken then alſo appears to have lungs. On the tenth the muſcles of the wings appear, and the feathers begin to puſh out. On the eleventh, the heart, which hitherto had appeared divided, begins to unite; the arteries which belong to it, join into it, like the fingers into the palm of the hand. All theſe appearances only come more into view, becauſe the fluids the veſſels had hitherto ſecreted, were more tranſparent; but as the colour of the fluids deepen, their operations and circulations are more diſtinctly ſeen. As the animal thus, by the eleventh day completely formed, begins to gather ſtrength, it becomes more uneaſy in its ſituation, and exerts its animal powers with increaſing force. For ſome time before it is able to break the ſhell in which it is impriſoned, it is heard to chirrup, receiving a ſufficient quantity of air for this purpoſe, from that cavity which lies between the membrane and the ſhell, and which muſt contain air to reſiſt the external preſſure. At length, upon the twentieth day, in ſome birds ſooner, and later in others, the incloſed animal breaks the ſhell, within which it has been confined, with its beak; and, by repeated efforts, at laſt procures its enlargement.

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* Malpighi. † Harvey.

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* Haller.

From this little hiſtory we perceive, that thoſe parts which are moſt conducive to life, are the firſt that are begun: the head and the back bone, which, no doubt, incloſe the brain, and the ſpinal marrow, though both are too limpid to be diſcerned, are the firſt that are ſeen to exiſt; the beating of the heart is perceived ſoon after: the leſs noble parts ſeem to ſpring from theſe; the wings, the thighs, the feet, and, laſtly, the bill. Whatever, therefore, the animal has double, or whatever it can live without the uſe of, theſe are lateſt in production: Nature firſt ſeduloufly applying to the formation of the nobler organs, without which life would be of ſhort continuance, and begun in vain.

The reſemblance between the beginning animal in the egg, and the embryo in the womb, is very ſtriking; and this ſimimilitude has induced many to aſſert, that all animals are produced from eggs, in the ſame manner. They conſider an egg excluded from the body by ſome, and ſeparated into the womb by others, to be actions merely of one kind; with this only difference, that the nouriſhment of the one is kept within the body of the parent, and increaſes as the embryo happens to want the ſupply; the nouriſhment of the other is prepared all at once, and ſent out with the beginning animal, as entirely ſufficient for its future ſupport. But leaving this to the diſcuſſion of anatomiſts, let us proceed rather with facts than diſſertations; and, as we have ſeen the progreſs of an oviparous animal, or one produced from the ſhell, let us likewiſe trace that of a viviparous animal, which is brought forth alive. In this inveſtigation, Graaf has, with a degree of patience, characteriſtic of his nation, attended the progreſs and increaſe of various animals in the womb, and minutely marked the changes they undergo. Having diſſected a rabbit, half an hour after impregnation, he perceived the horns of the womb, that go to embrace and communicate with the ovary, to be more red than before; but no other change in the reſt of the parts. Having diſſected another, ſix hours after, he perceived the follicules, or the membrane covering the eggs contained in the ovary, to become reddiſh. In a rabbit diſſected after twenty-four hours, he perceived, in one of the ovaries, three follicules, and, in the other, five, that were changed; being become, from tranſparent, dark and reddiſh. In one diſſected after three days, he perceived the horns of the womb very ſtrictly to embrace the ovaries; and he obſerved three of the follicules in one of them, much longer and harder than before: purſuing his inquiſition, he alſo found two of the eggs actually ſeparated into the horns of the womb, and each about the ſize of a grain of muſtard-ſeed; theſe little eggs were each of them incloſed in a double membrane, the inner parts being filled with a very limpid liquor. After four days, he found, in one of the ovaries, four, and, in the other, five follicules, emptied of their eggs; and in the horns correſpondent to theſe, he found an equal number of eggs thus ſeparated; theſe eggs were now grown larger than before, and ſomewhat of the ſize of ſparrow-ſhot. In five days, the eggs were grown to the ſize of duck-ſhot, and could be blown from the part of the womb where they were, by the breath. In ſeven days, theſe eggs were found of the ſize of a piſtol-bullet, each covered with its double membrane, and, theſe much more diſtinct than before.— In nine days, having examined the liquor contained in one of theſe eggs, he found it, from a limpid colour, leſs fluid, to have got a light cloud floating upon it. In ten days, this cloud began to thicken, and to form an oblong body, of the figure of a little worm: and, in twelve days, the figure of the embryo was diſtinctly to be perceived, and even its parts came into view. In the region of the breaſt he perceived two bloody ſpecks; and two more that appeared whitiſh. Fourteen days after impregnation, the head of the embryo was become large and tranſparent, the eyes prominent, the mouth open, and the rudiments of the ears beginning to appear; the back-bone, of a whitiſh colour, was bent towards the breaſt; the two bloody ſpecks being now conſiderably increaſed, appeared to be nothing leſs than the outlines of the two ventricles of the heart; and the two whitiſh ſpecks on each ſide, now appeared to be the rudiments of the lungs; towards the region of the belly, the liver began to be ſeen, of a reddiſh colour, and a little intricate maſs, like ravelled thread, diſcerned, which ſoon appeared to be the ſtomach and the inteſtines; the legs ſoon after began to be ſeen, and to aſſume their natural poſitions: and from that time forth, all the parts being formed, every day only ſerved to develope them ſtill more, until the thirty-firſt day, when the rabbit brought forth her young, completely fitted for the purpoſes of their humble happineſs.

Having thus ſeen the ſtages of generation in the meaner animals, let us take a view of its progreſs in MAN; and trace the feeble beginnings of our own exiſtence. An account of the lowlineſs of our own origin, if it cannot amuſe, will at leaſt ſerve to humble us; and it may take from our pride, though it fails to gratify our curioſity. We cannot here trace the variations of the beginning animal, as in the former inſtances; for the opportunities of inſpection are but few and accidental: for this reaſon, we muſt be content often to fill up the blanks of our hiſtory with conjecture. And, firſt, we are entirely ignorant of the ſtate of the infant in the womb, immediately after conception; but we have good reaſon to believe, that it proceeds, as in moſt other animals, from the egg*. Anatomiſts inform us, that four days after conception, there is found in the womb, an oval ſubſtance, about the ſize of a ſmall pea, but longer one way than the other; this little body is formed by an extremely fine membrane, incloſing a liquor a good deal reſembling the white of an egg: in this may, even then, be perceived, ſeveral ſmall fibres, united together, which form the firſt rudiments of the embryo. Beſides theſe, are ſeen another ſet of fibres, which ſoon after become the placenta, or that body by which the animal is ſupplied with nouriſhment.

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* This hiſtory of the child in the womb is tranſlated from Mr. Buffon, with ſome alterations.

Seven days after conception, we can readily diſtinguiſh, by the eye, the firſt lineaments of the child in the womb.—However, they are as yet without form; ſhewing at the end of ſeven days pretty much ſuch an appearance as that of the chicken after four and twenty hours, being a ſmall jelly-like maſs, yet exhibiting the rudiments of the head; the trunk is barely viſible; there likewiſe is to be diſcerned a ſmall aſſemblage of fibres iſſuing from the body of the infant, which afterwards become the blood-veſſels that convey nouriſhment from the placenta to the child, while incloſed in the womb.

Fifteen days after conception, the head becomes diſtinctly viſible, and even the moſt prominent features of the viſage begin to appear. The noſe is a little elevated; there are two black ſpecks in the place of eyes; and two little holes, where the ears are afterwards ſeen. The body of the embryo alſo, is grown larger; and both above and below, are ſeen two little protuberances, which mark the places from whence the arms and thighs are to proceed. The length of the whole body, at this time, is leſs than half an inch.

At the end of three weeks, the body has received very little increaſe; but the legs and feet, with the hands and arms, are become apparent. The growth of the arms is more ſpeedy than that of the legs; and the fingers are ſooner ſeparated than the toes. About this time, the internal parts are found, upon diſſection, to become diſtinguiſhable. The places of the bones are marked by ſmall thread-like ſubſtances, that are yet more fluid even than a jelly. Among them, the ribs are diſtinguiſhable, like threads alſo, diſpoſed on each ſide of the ſpine; and even the fingers and toes ſcarce exceed hairs in thickneſs.

In a month, the embryo is an inch long; the body is bent forward, a ſituation which it almoſt always aſſumes in the womb, either becauſe a poſture of this kind is the moſt eaſy, or becauſe it takes up the leaſt room. The human figure is now no longer doubtful: every part of the face is diſtinguiſhable; the body is ſketched out; the bowels are to be diſtinguiſhed as threads; the bones are ſtill quite ſoft, but in ſome places beginning to aſſume a greater rigidity; the blood-veſſels that go to the placenta, which, as was ſaid, contributes to the child's nouriſhment, are plainly ſeen iſſuing from the navel (being therefore called the *umbilical veſſels*), and going to ſpread themſelves upon the placenta. According to Hippocrates, the male embryo developes ſooner than the female: he adds, that, at the end of thirty days, the parts of the body of the male are diſtinguiſhable; while thoſe of the female are not equally ſo till ten days after.

In ſix weeks, the embryo is grown two inches long; the human figure begins to grow every day more perfect; the head being ſtill much larger, in proportion to the reſt of the body; and the motion of the heart is perceived almoſt by the eye. It has been ſeen to beat in an embryo of fifty days old, a long time after it had been taken out of the womb.

In two months the embryo is more than two inches in length. The oſſification is perceivable in the arms and thighs, and in the point of the chin, the under jaw being greatly advanced before the upper. Theſe parts, however, may as yet be conſidered as bony points, rather than as bones. The umbilical veſſels, which before went ſide by ſide, are now begun to be twiſted, like a rope, one over the other, and go to join with the placenta, which, as yet, is but ſmall.

In three months, the embryo is above three inches long, and weighs about three ounces. Hippocrates obſerves, that not till then the mother perceives the child's motion; and he adds, that in female children, the motion is not obſervable till the end of four months. However, this is no general rule, as there are women who aſſert, that they perceived themſelves to be quick with child, as their expreſſion is, at the end of two months; ſo that this quickneſs ſeems rather to ariſe from the proportion between the child's ſtrength, and the mother's ſenſibility, than from any determinate period of time. At all times, however, the child is equally alive; and, conſequently, thoſe juries of matrons that are to determine upon the pregnancy of criminals, ſhould not inquire whether the woman be quick, but whether ſhe be with child; if the latter be perceivable, the former follows of courſe.

Four months and an half after conception, the embryo is from ſix to ſeven inches long. All the parts are ſo augmented, that even their proportions are now diſtinguiſhable. The very nails begin to appear upon the fingers and toes; and the ſtomach and inteſtines already begin to perform their functions of receiving and digeſting. In the ſtomach is found a liquor ſimilar to that in which the embryo floats; in one part of the inteſtines, a milky ſubſtance; and, in the other, an excrementitious. There is found, alſo, a ſmall quantity of bile in the gall-bladder; and ſome urine in its own proper receptacle. By this time alſo, the poſture of the embryo ſeems to be determined. The head is bent forward, ſo that the chin ſeems to reſt upon its breaſt; the knees are raiſed up towards the head, and the legs bent backward, ſomewhat reſembling the poſture of thoſe who ſit upon their haunches. Sometimes the knees are raiſed ſo high as to touch the cheeks, and the feet are croſſed over each other; the arms are laid upon the breaſt, while one of the hands, and often both, touch the viſage; ſometimes the hands are ſhut, and ſometimes alſo, the arms are found hanging down by the body. Theſe are the moſt uſual poſtures which the embryo aſſumes; but theſe it is frequently known to change; and it is owing to theſe alterations that the mother ſo frequently feels thoſe twitches, which are uſually attended with pain.

The embryo, thus ſituated, is furniſhed by Nature with all things proper for its ſupport; and, as it increaſes in ſize, its nouriſhment alſo is found to increaſe with it. As ſoon as it firſt begins to grow in the womb, that receptacle, from being very ſmall, grows larger; and, what is more ſurpriſing, thicker every day. The ſides of a bladder, as we know, the more they are diſtended, the more they become thin. But here the larger the womb grows, the more it appears to thicken. Within this the embryo is ſtill farther involved, in two membranes, called the *chorion* and *amnios;* and floats in a thin tranſparent fluid, upon which it ſeems, in ſome meaſure, to ſubſiſt. However, the great ſtorehouſe, from whence its chief nouriſhment is ſupplied, is called the *placenta;* a red ſubſtance ſomewhat reſembling a ſponge, that adheres to the inſide of the womb, and communicates to the umbilical veſſels, with the embryo. Theſe umbilical veſſels, which conſiſt of a vein and two arteries, iſſue from the navel of the child, and are branched out upon the placenta; where they, in fact, ſeem to form its ſubſtance; and, if I may ſo expreſs it, to ſuck up their nouriſhment from the womb, and the fluids contained therein. The blood thus received from the womb, by the placenta, and communicated by the umbilical vein to the body of the embryo, is conveyed to the heart; where, without ever paſſing into the lungs, as in the born infant, it takes a ſhorter courſe; for entering the right auricle of the heart, inſtead of paſſing up into the pulmonary artery, it ſeems to break this partition, and goes directly through the body of the heart, by an opening called the *foramen ovale*, and from thence to the aorta, or great artery; by which it is driven into all parts of the body. Thus we ſee the placenta, in ſome meaſure, ſupplying the place of lungs; for as the little animal can receive no air by inſpiration, the lungs are therefore uſeleſs. But we ſee the placenta converting the fluid of the womb into blood, and ſending it, by the umbilical vein, to the heart; from whence it is deſpatched by a quicker and ſhorter circulation through the whole frame.

In this manner the embryo repoſes in the womb; ſupplied with that nouriſhment which is fitted to its neceſſities, and furniſhed with thoſe organs that are adapted to its ſituation. As its ſenſations are but few, its wants are in the ſame proportion; and it is probable that a ſleep, with ſcarce any intervals, marks the earlieſt period of animal life. As the little creature, however, gathers ſtrength and ſize, it ſeems to become more wakeful and uneaſy; even in the womb it begins to feel the want of ſomething it does not poſſeſs; a ſenſation that ſeems coeval with man's nature, and never leaves him till he dies. The embryo even then begins to ſtruggle for a ſtate more marked by pleaſure and pain, and, from about the ſixth month, begins to give the mother warning of the greater pain ſhe is yet to endure. The continuation of pregnancy, in woman, is uſually nine months; but there have been many inſtances when the child has lived that was born at ſeven; and ſome are found to continue pregnant a month above the uſual time. When the appointed time approaches, the infant, that has for ſome months been giving painful proofs of its exiſtence, now begins to increaſe its efforts for liberty. The head is applied downward, to the aperture of the womb, and by reiterated efforts it endeavours to extend the ſame: theſe endeavours produce the pain, which all women, in labour, feel in ſome degree; thoſe of ſtrong conſtitutions the leaſt, thoſe moſt weakly, the moſt ſeverely: ſince we learn, that the women of Africa always deliver themſelves, and are well a few hours after; while thoſe of Europe require aſſiſtance, and recover more ſlowly. Thus the infant, ſtill continuing to puſh with its head forward, by the repetition of its endeavours, at laſt ſucceeds, and iſſues into life. The blood, which has hitherto paſſed through the heart, now takes a wider circuit; and the foramen ovale cloſes; the lungs, that had till this time been inactive, now firſt begin their functions; the air ruſhes in to diſtend them; and this produces the firſt ſenſation of pain, which the infant expreſſes by a ſhriek: ſo that the beginning of our lives, as well as the end, is marked with anguiſh*.

From comparing theſe accounts, we perceive that the moſt laboured generation is the moſt perfect; and that the animal, which, in proportion to its bulk, takes the longeſt time for production, is always the moſt complete when finiſhed. Of all others, man ſeems the ſloweſt in coming into life, as he is the ſloweſt in coming to perfection; other animals, of the ſame bulk, ſeldom remain in the womb above ſix months, while he continues nine; and even after his birth appears more than any other to have his ſtate of imbecility prolonged.

We may obſerve alſo, that that generation is the moſt complete in which the feweſt animals are produced: Nature, by attending to the production of one at a time, ſeems to exert all her efforts in bringing it to perfection; but, where this attention is divided, the animals ſo produced come into the world with partial advantages. In this manner twins are never, at leaſt while infants, ſo large, or ſo ſtrong as thoſe that come ſingly into the world; each having, in ſome meaſure, robbed the other of its right; as that ſupport, which Nature meant for one, has been prodigally divided.

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* Bonet Contemplat. de la Nature, vol. i. p. 212.

In this manner, as thoſe animals are the beſt that are produced ſingly, ſo we find that the nobleſt animals are ever the leaſt fruitful. Theſe are ſeen uſually to bring forth but one at a time, and to place all their attention upon that alone. On the other hand, all the oviparous kinds produce an amazing plenty; and even the lower tribes of viviparous animals increaſe in a ſeeming proportion to their minuteneſs and imperfection. Nature ſeems laviſh of life in the lower orders of the creation; and, as if ſhe meant them entirely for the uſe of the nobler races, ſhe appears to have beſtowed greater pains in multiplying the number than in completing the kind. In this manner, while the elephant and the horſe, bring forth but one at a time, the ſpider and the beetle are ſeen to produce a thouſand: and even among the ſmaller quadrupeds, all the inferior kinds are extremely fertile; any one of theſe being found, in a very few months, to become the parent of a numerous progeny.

In this manner, therefore, the ſmalleſt animals multiply in the greateſt proportion; and we have reaſon to thank Providence that the moſt formidable animals are the leaſt fruitful. Had the lion and the tiger the ſame degree of fecundity with the rabbit or the rat, all the arts of man would be unable to oppoſe theſe fierce invaders; and we ſhould ſoon perceive them become the tyrants of thoſe who claim the lordſhip of the creation. But Heaven, in this reſpect, has wiſely conſulted the advantage of all. It has oppoſed to man only ſuch enemies as he has art and ſtrength to conquer; and as large animals require proportional ſupplies, Nature was unwilling to give new life, where it, in ſome meaſure, denied the neceſſary means of ſubſiſtence.

In conſequence of this pre-eſtabliſhed order, the animals that are endowed with the moſt perfect methods of generation, and bring forth but one at a time, ſeldom begin to procreate till they have almoſt acquired their full growth. On the other hand, thoſe which bring forth many, engender before they have arrived at half their natural ſize. The horſe and the bull come almoſt to perfection before they begin to generate; the hog and the rabbit ſcarce leave the teat before they become parents themſelves. In whatever light, therefore, we conſider this ſubject, we ſhall find that all creatures approach moſt to perfection, whoſe generation moſt nearly reſembles that of man. The reptile produced from cutting is but one degree above the vegetable. The animal produced from the egg is a ſtep higher in the ſcale of exiſtence; that claſs of animals which are brought forth alive, are ſtill more exalted. Of theſe, ſuch as bring forth one at a time are the moſt complete; and the foremoſt of theſe ſtands Man, *the great maſter of all*, who ſeems to have united the perfections of all the reſt in his formation.

CHAP. II.

THE INFANCY OF MAN.

WHEN we take a ſurvey of the various claſſes of animals, and examine their ſtrength, their beauty, or their ſtructure, we ſhall find man to poſſeſs moſt of thoſe advantages united, which the reſt enjoy partially. Infinitely ſuperior to all others in the powers of the underſtanding, he is alſo ſuperior to them in the fitneſs and proportions of his form. He would, indeed, have been one of the moſt miſerable begins upon earth, if with a ſentient mind he was ſo formed as to be incapable of obeying its impulſe; but Nature has otherwiſe provided; as with the moſt extenſive intellects to command, ſhe has furniſhed him with a body the beſt fitted for obedience.

In infancy*, however, that mind, and this body, form the moſt helpleſs union in all Animated Nature; and, if any thing can give us a picture of complete imbicility, it is a man when juſt come into the world. The infant juſt born ſtands in need of all things, without the power of procuring any. The low races of animals, upon being produced, are active, vigorous, and capable of ſelf-ſupport; but the infant is obliged to wait in helpleſs expectation; and its cries are its only aid to procure ſubſiſtence.

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* Buffon, vol. iv. p. 173.

An infant juſt born may be ſaid to come from one element into another: for, from the watery fluid in which it was ſurrounded, it now immerges into air; and its firſt cries ſeem to imply how greatly it regrets the change. How much longer it could have continued in a ſtate of almoſt total inſenſibility, in the womb, is impoſſible to tell: but it is very probable that it could remain there ſome hours more. In order to throw ſome light upon this ſubject, Mr. Buffon ſo placed a pregnant bitch, as that her puppies were brought forth in warm water, in which he kept them above half an hour at a time. However he ſaw no change in the animals, thus newly brought forth; they continued the whole time vigorous; and, during the whole time, it is very probable that the blood circulated through the ſame channels through which it paſſed while they continued in the womb.

Almoſt all animals have their eyes cloſed*, for ſome days after being brought into the world. The infant opens them the inſtant of its birth. However, it ſeems to keep them fixed and idle; they want that luſtre which they acquire by degrees; and if they happen to move, it is rather an accidental gaze than an exertion of the act of ſeeing. The light alone ſeems to make the greateſt impreſſion upon them. The eyes of infants are ſometimes found turned to the place where it is ſtrongeſt; and the pupil is ſeen to dilate and diminiſh, as in grown perſons, in proportion to the quantity it receives. But ſtill the infant is incapable of diſtinguiſhing objects; the ſenſe of ſeeing, like the reſt of the ſenſes, requires an habit before it becomes any way ſerviceable. All the ſenſes muſt be compared with each other, and muſt be made to correct the defects of one another, before they can give juſt information. It is probable, therefore, that if the infant could expreſs its own ſenſations, it would give a very extraordinary deſcription of the illuſions which it ſuffers from them. The ſight might, perhaps, be repreſented as inverting objects, or multiplying them; the hearing, inſtead of conveying one uniform tone, might be ſaid to bring up an interrupted ſucceſſion of noiſes; and the touch apparently would divide one body into as many as there are fingers that graſped it. But all theſe errors are loſt in one confuſed idea of exiſtence; and it is happy for the infant that it then can make but very little uſe of its ſenſes, when they could ſerve only to bring it falſe information.

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* Buffon, vol. iv. p. 173.

If there be any diſtinct ſenſations, thoſe of pain ſeem to to be much more frequent and ſtronger than thoſe of pleaſure. The infant's cries are ſufficient indications of the uneaſineſſes it muſt at every interval endure: while, in the beginning, it has got no external marks to teſtify its ſatisfactions. It is not till after forty days that it is ſeen to ſmile; and not till that time alſo, that the tears begin to appear, its former expreſſions of uneaſineſs being always without them. As to any other marks of the paſſions, the infant being as yet almoſt without them, it can expreſs none of them in its viſage; which, except in the act of crying and laughing, is fixed in a ſettled ſerenity. All the other parts of the body ſeem equally relaxed and feeble: its motions are uncertain, and its poſtures without choice; it is unable to ſtand upright; its hams are yet bent, from the habit which it received from its poſition in the womb; it has not ſtrength enough in its arms to ſtretch them forward, much leſs to graſp any thing with its hands; it reſts juſt in the poſture it is laid; and, if abandoned, muſt continue in the ſame poſition.

Nevertheleſs, though this be the deſcription of infancy among mankind in general, there are countries and races among whom infancy does not ſeem marked with ſuch utter imbecility, but where the children, not long after they are born, appear poſſeſſed of a greater ſhare of ſelf-ſupport. The children of Negroes have a ſurpriſing degree of this premature induſtry: they are able to walk at two months; or, at leaſt, to move from one place to another: they alſo hang to the mother's back without any aſſiſtance, and ſeize the breaſt over the ſhoulder; continuing in this poſture till ſhe thinks proper to lay them down. This is very different in the children of our countries, that ſeldom are able to walk under a twelvemonth.

The ſkin of children newly brought forth, is always red, proceeding from its tranſparency, by which the blood beneath appears more conſpicuous. Some ſay that this redneſs is greateſt in thoſe children that are afterwards about to have the fineſt complexions; and it appears reaſonable that it ſhould be ſo, ſince the thinneſt ſkins are always the faireſt. The ſize of a new-born infant is generally about twenty inches, and its weight about twelve pounds. The head is large, and all the members delicate, ſoft, and puffy. Theſe appearances alter with its age; as it grows older, the head becomes leſs in proportion to the reſt of the body; the fleſh hardens; the bones, that before birth grew very thick in proportion, now lengthen by degrees, and the human figure more and more acquires its due dimenſions. In ſuch children, however, as are but feeble or ſickly, the head always continues too big for the body; the heads of dwarfs being extremely large in proportion.

Infants, when newly born, paſs moſt of their time in ſleeping, and awake with crying; excited either by ſenſations of pain, or of hunger. Man, when come to maturity, but rarely feels the want of food, as eating twice or thrice in the four and twenty hours is known to ſuffice the moſt voracious: but the infant may be conſidered as a little glutton, whoſe only pleaſure conſiſts in its appetite; and this, except when it ſleeps, it is never eaſy without ſatisfying. Thus Nature has adapted different deſires to the different periods of life; each as it ſeems moſt neceſſary for human ſupport or ſucceſſion. While the animal is yet forming, hunger excites it to that ſupply which is neceſſary for its growth; when it is completely formed, a different appetite takes place, that incites it to communicate exiſtence. Theſe two deſires take up the whole attention at different periods, but are very ſeldom found to prevail ſtrongly together in the ſame age; one pleaſure ever ſerving to repreſs the other: and, if we find a perſon of full age, placing a principal part of his happineſs in the nature and quantity of his food, we have ſtrong reaſons to ſuſpect, that with reſpect to his other appetites, he ſtill retains a part of the imbecility of his childhood.

It is extraordinary, however, that infants, who are thus more voracious than grown perſons, are nevertheleſs more capable of ſuſtaining hunger. We have ſeveral inſtances, in accidental caſes of famine, in which the child has been known to ſurvive the parent, and ſeen clinging to the breaſt of their dead mother. Their little bodies alſo, are more patient of cold; and we have ſimilar inſtances of the mother's periſhing in the ſnow, while the infant has been found alive beſide her. However, if we examine the internal ſtructure of infants, we ſhall find an obvious reaſon for both theſe advantages. Their blood-veſſels are known to be much larger than in adults; and their nerves much thicker and ſofter: thus, being furniſhed with a more copious quantity of juices, both of the nervous and ſanguinary kinds, the infant finds a temporary ſuſtenance in this ſuperfluity, and does not expire till both are exhauſted. The circulation alſo being larger and quicker, ſupplies it with proportionable warmth, ſo that it is more capable of reſiſting the accidental rigours of the weather.

The firſt nouriſhment of infants is well known to be the mother's milk; and, what is remarkable, the infant has milk in its own breaſts, which may be ſqueezed out by compreſſion: this nouriſhment becomes leſs grateful as the child gathers ſtrength; and perhaps, alſo, more unwholeſome. However, in cold countries, which are unfavourable to propagation, and where the female has ſeldom above three or four children at the moſt, during her life, ſhe continues to ſuckle the child for four or five years together. In this manner the mothers of Canada and Greenland are often ſeen ſuckling two or three children, of different ages, at a time.

The life of infants is very precarious, till the age of three or four, from which time it becomes more ſecure; and when a child arrives at its ſeventh year, it is then conſidered as a more certain life, as Mr. Buffon aſſerts, than at any other age whatever. It appears, from Simpſon's Tables, that of a certain number of children born at the ſame time, a fourth part are found dead, at the end of the firſt year; more than two thirds at the end of the ſecond; and, at leaſt, half, at the end of the third: ſo that thoſe who live to be above three years old, are indulged a longer term than half the reſt of their fellow-creatures. Nevertheleſs, life, at that period, may be conſidered as mere animal exiſtence; and rather a preparation for, than an enjoyment of thoſe ſatisfactions, both of mind and body, that make life of real value: and hence it is more natural for mankind to deplore a fellow creature, cut off in the bloom of life, than one dying in early infancy. The one, by living up to youth, and thus wading through the diſadvantageous parts of exiſtence, ſeems to have earned a ſhort continuance of its enjoyments: the infant, on the contrary, has ſerved but a ſhort apprenticeſhip to pain; and, when taken away, may be conſidered as reſcued from a long continuance of miſery.

There is ſomething very remarkable in the growth of the human body* The embryo in the womb continues to increaſe ſtill more and more, till it is born. On the other hand, the child's growth is leſs every year, till the time of puberty, when it ſeems to ſtart up of a ſudden. Thus, for inſtance, the embryo, which is an inch long, in the firſt month, grows but one inch and a quarter in the ſecond; it then grows one and a half in the third; two and a half in the fourth; and in this manner it keeps increaſing, till in the laſt month of its continuance is it actually found to grow four inches; and, in the whole, about eighteen inches long. But it is otherwiſe with the child when born; if we ſuppoſe it eighteen inches at that time; it grows in the firſt year, ſix or ſeven inches; in the ſecond year, it grows but four inches; in the third year, about three; and ſo on, at the rate of about an inch and a half, or two inches, each year, till the time of puberty, when Nature ſeems to make one great laſt effort, to complete her work, and unfold the whole animal machine.

The growth of the mind in children ſeems to correſpond with that of the body. The comparative progreſs of the underſtanding is greater in infants than in children of three or four years old. If we only reflect a moment on the amazing acquiſitions that an infant makes in the firſt and ſecond years of life, we ſhall have much cauſe for wonder. Being ſent into a world where every thing is new and unknown, the firſt months of life are ſpent in a kind of torpid amazement; an attention diſtracted by the multiplicity of objects that preſs to be known. The firſt labour, therefore, of the little learner is, to correct the illuſions of the ſenſes, to diſtinguiſh one object from another, and to exert the memory, ſo as to know them again. In this manner a child of a year old has already made a thouſand experiments; all which it has properly ranged, and diſtinctly remembers. Light, heat, fire, ſweets, and bitters, ſounds ſoft or terrible, are all diſtinguiſhed at the end of a very few months. Beſides this, every perſon the child knows, every individual object it becomes fond of, its rattles, or its bells, may be all conſidered as ſo many new leſſons to the young mind, with which it has not become acquainted, without repeated exertions of the underſtanding. At this period of life, the knowledge of every individual object cannot be acquired without the ſame effort which, when grown up, is employed upon the moſt abſtract idea: every thing the child hears or ſees, all the marks and characters of Nature, are as much unknown, and require the ſame attention to attain, as if the reader were ſet to underſtand the characters of an Ethiopic manuſcript; and yet we ſee in how ſhort a time the little ſtudent begins to underſtand them all, and to give evident marks of early induſtry.

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* Buffon, Vol. iv. p. 173.

It is very amuſing to purſue the young mind, while employed in its firſt attainments. At about a year old the ſame neceſſities that firſt engaged its faculties, increaſe as its acquaintance with Nature enlarges. Its ſtudies, therefore, if I may uſe the expreſſion, are no way relaxed; for having experienced what gave pleaſure at one time, it deſires a repetition of it from the ſame object; and, in order to obtain this, that object muſt be pointed out; here, therefore, a new neceſſity ariſes, which, very often, neither its little arts nor importunities can remove; ſo that the child is at laſt obliged to ſet about naming the objects it deſires to poſſeſs or avoid. In beginning to ſpeak, which is uſually about a year old, children find a thouſand difficulties. It is not without repeated trials that they come to pronounce any one of the letters; nor without an effort of the memory, that they can retain them. For this reaſon, we frequently ſee them attempting a ſound which they had learned, but forgot; and when they have failed, I have often ſeen their attempt attended with apparent confuſion. The letters ſooneſt learned, are thoſe which are moſt eaſily formed; thus A and B require an obvious diſpoſitions of the organs, and their pronunciation is conſequently ſoon attained. Z and R, which require a more complicated poſition, are learned with greater difficulty. And this may, perhaps, be the reaſon why the children in ſome countries ſpeak ſooner than in others; for the letters moſtly occurring in the language of one country, being ſuch as are of eaſy pronunciation, that language is of courſe more eaſily attained. In this manner the children of the Italians are ſaid to ſpeak ſooner than thoſe of the Germans; the language of the one being ſmooth and open; that of the other, crowded with conſonants, and extremely gutteral.

But be this as it will, in all countries, children are found able to expreſs the greateſt part of their wants by the time they arrive at two years old; and from the moment the neceſſity of learning new words ceaſes, they relax their induſtry. It is then that the mind, like the body, ſeems every year to make ſlow advances; and, in order to ſpur up attention, many ſyſtems of education have been contrived.

Almoſt every philoſopher who has written on the education of children, has been willing to point out a method of his own, chiefly profeſſing to advance the health, and improve the intellects at the ſame time. Theſe are uſually found to begin with finding nothing right in the common practice; and by urging a total reformation. In conſequence of this nothing can be more wild or imaginary than their various ſyſtems of improvement. Some will have the children every day plunged in cold water, in order to ſtrengthen their bodies; they will have them converſe with the ſervants is nothing but the Latin language, in order to ſtrengthen their minds; every hour of the day muſt be appointed for its own ſtudies, and the child muſt learn to make theſe very ſtudies an amuſement; till about the age of ten or eleven it becomes a progidy of premature improvement. Quite oppoſite to this, we have others, whom the courteſy of mankind alſo calls *philoſophers:* and they will have the child learn nothing till the age of ten or eleven, at which the former has attained ſo much perfection; with them the mind is to be kept empty, until it has a proper diſtinction of ſome metaphyſical ideas about truth; and the promiſing pupil is debarred the uſe of even his own faculties, leſt they ſhould conduct him into prejudice and error. In this manner, ſome men, whom faſhion has celebrated for profound and fine thinkers, have given their hazarded and untried conjectures, upon one of the moſt important ſubjects in the world, and the moſt intereſting to humanity. When men ſpeculate at liberty upon innate ideas, or the abſtracted diſtinctions between will and power, they may be permitted to enjoy their ſyſtems at pleaſure, as they are harmleſs, although they may be wrong; but when they allege that children are to be every day plunged in cold water, and, whatever be their conſtitution, indiſcriminately enured to cold and moiſture; that they are to be kept wet in the feet, to prevent their catching cold; and never to be corrected when young, for fear of breaking their ſpirits when old; theſe are ſuch noxious errors, that all reaſonable men ſhould endeavour to oppoſe them. Many have been the children whom theſe opinions, begun in ſpeculation, have injured or deſtroyed in practice; and I have ſeen many a little philoſophical martyr, whom I wiſhed, but was unable, to relieve.

If any ſyſtem be therefore neceſſary, it is one that would ſerve to ſhew a very plain point; that very little ſyſtem is neceſſary. The natural and common courſe of education is in every reſpect the beſt: I mean that in which the child is permitted to play among its little equals, from whoſe ſimilar inſtructions it often gains the moſt uſeful ſtores of knowledge. A child is not idle becauſe it is playing about the fields, or purſuing a butterfly; it is all this time ſtoring its mind with objects, upon the nature, the properties, and the relations of which future curioſity may ſpeculate.

I have ever found it a vain taſk to try to make a child's learning its amuſement; nor do I ſee what good end it would anſwer were it actually attained. The child, as was ſaid, ought to have its ſhare of play, and it will be benefited thereby; and for every reaſon alſo, it ought to have its ſhare of labour. The mind, by early labour, will be thus accuſtomed to fatigues and ſubordination; and whatever be the perſons future employment in life, he will be better fitted to endure it: he will be thus enabled to ſupport the drudgeries of office with content; or to fill up the vacancies of life with variety. The child, therefore, ſhould by times be put to its duty; and be taught to know, that the taſk is to be done, or the puniſhment to be endured. I do not object againſt alluring it to duty by reward; but we well know, that the mind will be more ſtrongly ſtimulated by pain; and both may, upon ſome occaſions, take their turn to operate. In this manner, a child, by playing with its equals abroad, and labouring with them at ſchool, will acquire more health and knowledge, than by being bred up under the wing of any ſpeculative ſyſtem-maker; and will be thus qualified for a life of activity and obedience. It is true indeed, that when educated in this manner, the boy may not be ſo ſeemingly ſenſible and forward as one bred up under ſolitary inſtruction; and, perhaps, this early forwardneſs is more engaging than uſeful. It is well known, that many of thoſe children who have been ſuch prodigies of literature before ten, have not made an adequate progreſs to twenty. It ſhould ſeem, that they only began learning manly things before their time; and, while others were buſied in picking up that knowledge adapted to their age and curioſity, theſe were forced upon ſubjects unſuited to their years; and, upon that account alone, appearing extraordinary. The ſtock of knowledge in both may be equal; but with this difference, that each is yet to learn what the other knows.

But whatever may have been the acquiſitions of children at ten or twelve, their greateſt, and moſt rapid progreſs, is made when they arrive near the age of puberty. It is then that all the powers of Nature ſeem at work in ſtrengthening the mind and completing the body: the youth acquires courage, and the virgin modeſty; the mind, with new ſenſations, aſſumes new powers; it conceives with greater force, and remembers with great tenacity. About this time, therefore, which is various in different countries, more is learned in one year than in any two of the preceding; and on this age, in particular, the greateſt weight of inſtruction ought to be thrown.

CHAP. IV.

OF PUBERTY.

IT has been often ſaid, that the ſeaſon of youth is the ſeaſon of pleaſures: but this can only be true in ſavage countries, where but little preparation is made for the perfection of human nature; and where the mind has but a very ſmall part in the enjoyment. It is otherwiſe in thoſe places where Nature is carried to the higheſt pitch of refinement, in which this ſeaſon of the greateſt ſenſual delight is wiſely made ſubſervient to the ſucceeding, and more rational one of manhood. Youth, with us, is but a ſcene of preparation; a drama, upon the right conduct of which all future happineſs is to depend. The youth who follows his appetites, too ſoon ſeizes the cup, before it has received its beſt ingredients; and, by anticipating his pleaſures, robs the remaining parts of life of their ſhare; ſo that his eagerneſs only produces a manhood of imbecility, and an age of pain.

The time of puberty is different in various countries, and always more late in men than in women. In the warm countries of India, the women are marriageable at nine or ten, and the men at twelve or thirteen. It is alſo different in cities, where the inhabitants lead a more ſoft, luxurious life, from the country, where they work harder, and fare leſs delicately. Its ſymptoms are ſeldom alike in different perſons; but it is uſually known by a ſwelling of the breaſts in one ſex, and a roughneſs of the voice in the other. At this ſeaſon, alſo, the women ſeem to acquire new beauty, while the men loſe all that delicate effeminacy of countenance which they had when boys.

All countries, in proportion as they are civilized, or barbarous, improve, or degrade the nuptial ſatisfaction. In thoſe miſerable regions, where ſtrength makes the only law, the ſtronger ſex exerts its power, and becomes the tyrant over the weaker: while the inhabitant of Negroland is indolently taking his pleaſure in the fields, his wife is obliged to till the grounds that ſerve for their mutual ſupport. It is thus in all barbarous countries, where the men throw all the laborious duties of life upon the women; and, regardleſs of beauty, put the ſofter ſex to thoſe employments that muſt effectually deſtroy it.

But, in countries that are half barbarous, particularly wherever Mahometaniſm prevails, the men run into the very oppoſite extreme. Equally brutal with the former, they exert their tyranny over the weaker ſex, and conſider that half of the human creation as merely made to be ſubſervient to the depraved deſires of the other. The chief, and, indeed, the only aim of an Aſiatic, is to be poſſeſſed of many women; and to be able to furniſh a ſeraglio is the only tendency of his ambition. As the ſavage was totally regardleſs of beauty, he, on the conttary, prizes it too highly; he excludes the perſon who is poſſeſſed of ſuch perſonal attractions, from any ſhare in the duties or employments of life; and, as if willing to engroſs all beauty to himſelf, increaſes the number of his captives in proportion to the progreſs of his fortune. In this manner he vainly expects to augment his ſatisfactions, by ſeeking from many that happineſs which he ought to look for in the ſociety of one alone. He lives a gloomy tyrant, amidſt wretches of his own making; he feels none of thoſe endearments which ſpring from affection, none of thoſe delicacies which ariſe from knowledge. His miſtreſſes, being ſhut out from the world, and totally ignorant of all that paſſes there, have no arts to entertain his mind, or calm his anxieties; the day paſſes with them in ſullen ſilence, or languid repoſe; appetite can furniſh but few opportunities of varying the ſcene; and all that falls beyond it muſt be irkſome expectation.

From this avarice of women, if I may be allowed to expreſs it ſo, has proceeded that jealouſy and ſuſpicion which ever attends the miſer: hence thoſe low and barbarous methods of keeping the women of thoſe countries guarded, and of making and procuring eunuchs to attend them. Theſe unhappy creatures are of two kinds, the white and the black. The white are generally made in the country where they reſide, being but partly deprived of the marks of virility; the black are generally brought from the interior parts of Africa, and are made entirely bare. Theſe are chiefly choſen for their deformity; the thicker the lips, the flatter the noſe, and the more black the teeth, the more valuable the eunuch; ſo that the vile jealouſy of mankind here inverts the order of Nature, and the poor wretch finds himſelf valued in proportion to his deficiencies. In Italy, where this barbarous cuſtom is ſtill retained, and eunuchs are made in order to improve the voice, the laws are ſeverely aimed againſt ſuch practice; ſo that being entirely prohibited, none but the pooreſt, and moſt abandoned of the people, ſtill ſecretly practiſe it upon their children. Of thoſe ſerved in this manner, not one in ten is found to become a ſinger; but ſuch is the luxurious folly of the times, that the ſucceſs of one amply compenſates for the failure of the reſt. It is very difficult to account for the alterations which caſtration makes in the voice, and the other parts of the body. The eunuch is ſhaped differently from others. His legs are of an equal thickneſs above and below; his knees weak; his ſhoulders narrow; and his beard thin and downy. In this manner his perſon is rendered more deformed; but his deſires, as I am told, ſtill continue the ſame; and actually, in Aſia, ſome of them are found to have their ſeraglios, as well as their maſters. Even in our country, we have an inſtance of a very fine woman's being married to one of them, whoſe appearance was the moſt unpromiſing; and what is more extraordinary ſtill, I am told, that this couple continue perfectly happy in each other's ſociety.

The mere neceſſities of life ſeem the only aim of the ſavage; the ſenſual pleaſures are the only ſtudy of the ſemibarbarian; but the refinement of ſenſuality, by reaſon, is the boaſt of real politeneſs. Among the merely barbarous nations, ſuch as the natives of Madagaſcar, or the inhabitants of Congo, nothing is deſired ſo ardently as to proſtitute their wives, or daughters, to ſtrangers, for the moſt trifling advantages; they will account it a diſhonour not to be among the foremoſt who are thus received into favour; on the other hand, the Mahometan keeps his wife faithful, by confining her perſon; and would inſtantly put her to death if he but ſuſpected her chaſtity. With the politer inhabitants of Europe both theſe barbarous extremes are avoided; the woman's perſon is left free, and no conſtraint is impoſed but upon her affections. The paſſion of love, which may be conſidered as the nice conduct of ruder deſire, is only known and practiſed in this part of the world; ſo that what other nations guard as their right, the more delicate European is contented to aſk as a favour. In this manner, the concurrence of mutual appetite contributes to increaſe mutual ſatisfaction; and the power on one ſide of refuſing makes every bleſſing more grateful when obtained by the other. In barbarous countries, woman is conſidered merely as an uſeful ſlave; in ſuch as are ſomewhat more refined, ſhe is regarded as a deſirable toy; in countries entirely poliſhed ſhe enjoys juſter privileges; the wife being conſidered as an uſeful friend, and an agreeable miſtreſs. Her mind is ſtill more prized than her perſon; and without the improvement of both, ſhe can never expect to become truly agreeable; for her good ſenſe alone can preſerve what ſhe has gained by her beauty.

Female beauty, as was ſaid, is always ſeen to improve about the age of puberty: but if we ſhould attempt to define in what this beauty conſiſts or what conſtitutes its perfection, we ſhould find nothing more difficult to determine. Every country has its peculiar way of thinking, in this reſpect; and even the ſame country thinks differently at different times. The ancients had a very different taſte from what prevails at preſent. The eye-brows joining in the middle was conſidered as a very peculiar grace by Tibullus, in the enumeration of the charms of his miſtreſs. Narrow foreheads were approved of, and ſcarce any of the Roman ladies that are celebrated for their other perfections, but are alſo praiſed for the redneſs of their hair. The noſe alſo of the Grecian Venus, was ſuch as would appear at preſent an actual deformity; as it fell in a ſtraight line from the forehead, without the ſmalleſt ſinking between the eyes without which we never ſee a face at preſent.

Among the moderns, every country ſeems to have peculiar ideas of beauty*. The Perſians admire large eye-brows, joining in the middle; the edges and corners of the eyes are tinctured with black, and the ſize of the head is increaſed by a great variety of bandages, formed into a turban. In ſome parts of India, black teeth and white hair are deſired with ardour; and one of the principal employments of the women of Thibet, is to redden the teeth with herbs, and to make their hair white by a certain preparation. The paſſion for coloured teeth obtains alſo in China and Japan; where, to complete their idea of beauty, the object of deſire muſt have little eyes, nearly cloſed, feet extremely ſmall, and a waiſt far from being ſhapely. There are ſome nations of the American Indians that flatten the heads of their children, by keeping them, while young, ſqueezed between two boards, ſo as to make the viſage much larger than it would naturally be. Others flatten the head at top; and others ſtill make it as round as they poſſibly can. The inhabitants along the weſtern coaſts of Africa, have a very extraordinary taſte for beauty. A flat noſe, thick lips, and a jet-black complexion, are there the moſt indulgent gifts of Nature. Such, indeed, they are all, in ſome degree, found to poſſeſs. However, they take care, by art, to increaſe theſe natural deformities, as they ſhould ſeem to us; and they have many additional methods of rendering their perſons ſtill more frightfully pleaſing. The whole body and viſage is often ſcarred with a variety of monſtrous figures; which is not done without great pain, and repeated inciſion; and even ſometimes, parts of the body are cut away. But it would be endleſs to remark the various arts which caprice, or cuſtom, has employed to diſtort and disfigure the body, in order to render it more pleaſing: in fact, every nation, how barbarous ſoever, ſeems unſatisfied with the human figure, as Nature has left it, and has its peculiar arts of heightening beauty. Painting, powdering, cutting, boring the noſe and the ears, lengthening the one, and depreſſing the other, are arts practiſed in many countries; and, in ſome degree, admired in all. Theſe arts might have been at firſt introduced to hide epidemic deformities; cuſtom, by degrees, reconciles them to the view; till, from looking upon them with indifference, the eye at length begins to gaze with pleaſure.

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* Buffon.

CHAP. V.

OF THE AGE OF MANHOOD*.

THE human body attains to its full height during the age of puberty; or, at leaſt, a ſhort time after. Some young people are found to ceaſe growing at fourteen or fifteen; others continue their growth till two or three and twenty. During this period they are all of a ſlender make; their thighs and legs ſmall, and the muſcular parts as yet unfilled. But, by degrees, the fleſhy fibres augment; the muſcles ſwell, and aſſume their figure; the limbs become proportioned, and rounder; and, before the age of thirty, the body, in men, has acquired the moſt perfect ſymmetry. In women, the body arrives at perfection much ſooner, as they arrive at the age of maturity more early; the muſcles, and all the other parts being weaker, leſs compact and ſolid, than thoſe of man, they require leſs time in coming to perfection; and, as they are leſs in ſize, that ſize is ſooner completed. Hence the perſons of women are found to be as complete at twenty, as thoſe of men are found to be at thirty.

The body of a well-ſhaped man ought to be ſquare; the muſcles ſhould be expreſſed with boldneſs, and the lines of the face ſtrongly marked. In the woman, all the limbs ſhould be rounder, the lines ſofter, and the features more delicate. Strength and majeſty belong to the man, grace and ſoftneſs are the peculiar embelliſhments of the other ſex. In both, every part of their form declares their ſovereignty over other creatures. Man ſupports his body erect; his attitude is that of command; and his face, which is turned towards the heavens, diſplays the dignity of his ſtation. The image of his ſoul is painted in his viſage; and the excellence of his nature penetrates through the material form in which it is incloſed. His majeſtic port, his ſedate and reſolute ſtep, announce the nobleneſs of his rank. He touches the earth only with his extremity; and beholds it as if at a diſdainful diſtance. His arms are not given him, as to other creatures, for pillars of ſupport; nor does he loſe, by rendering them callous againſt the ground, that delicacy of touch which furniſhes him with ſo many of his enjoyments. His hands are made for very different purpoſes; to ſecond every intention of his will, and to perfect the gifts of Nature.

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* This chapter is tranſlated from Mr. Buffon, whoſe deſcription is very excellent. Whatever I have added is marked by inverted commas, " thus." And in whatever trifling points I have differed, the notes will ſerve to ſhew.

When the ſoul is at reſt, all the features of the viſage ſeem ſettled in a ſtate of profound tranquillity. Their proportion, their union, and their harmony ſeem to mark the ſweet ſerenity of the mind, and give a true information of what paſſes within. But when the ſoul is excited, the human viſage becomes a living picture; where the paſſions are expreſſed with as much delicacy as energy, where every motion is deſigned by ſome correſpondent feature, where every impreſſion anticipates the will, and betrays thoſe hidden agitations, that he would often wiſh to conceal.

It is particularly in the eyes that the paſſions are painted; and in which we may moſt readily diſcover their beginning. The eye ſeems to belong to the ſoul more than any other organ; it ſeems to participate of all its emotions; as well the moſt ſoft and tender, as the moſt tumultuous and forceful. It not only receives, but tranſmits them by ſympathy; the obſerving eye of one catches the ſecret fire from another; and the paſſion thus often becomes general.

Such perſons as are ſhort-ſighted labour under a particular diſadvantage, in this reſpect. They are, in a manner, entirely cut off from the language of the eyes; and this gives an air of ſtupidity to the face, which often produces very unfavourable prepoſſeſſions. However intelligent we find ſuch perſons to be, we can ſcarcely be brought back from our firſt prejudice, and often continue in the firſt erroneous opinion. In this manner we are too much induced to judge of men by their phyſiognomy; and having, perhaps, at firſt, caught up our judgments prematurely, they mechanically influence us all our lives after. This extends even to the very colour, or the cut of people's clothes; and we ſhould for this reaſon be careful, even in ſuch trifling particulars, ſince they go to make up a part of the total judgment which thoſe we converſe with may form to our advantage.

The vivacity, or the languid motion of the eyes, gives the ſtrongeſt marks to phyſiognomy; and their colour contributes ſtill more to enforce the expreſſion. The different colours of the eye are the dark hazle, the light hazle, the green, the blue, and grey, the whitiſh grey, " and alſo the red." Theſe different colours ariſe from the different colours of the little muſcles that ſerve to contract the pupil; " and they are very often found to change colour with diſorder, and with age."

The moſt ordinary colours are the hazle and the blue, and very often both theſe colours are found in the eyes of the ſame perſon. Thoſe eyes which are called black, are only of the dark hazle, which may be eaſily ſeen upon cloſer inſpection; however, thoſe eyes are reckoned the moſt beautiful where the ſhade is the deepeſt: and either in theſe, or the blue eyes, the fire, which gives its fineſt expreſſion to the eye, is more diſtinguiſhable in proportion to the darkneſs of the tint. For this reaſon, the black eyes, as they are called, have the greateſt vivacity; but, probably, the blue have the moſt powerful effect in beauty, as they reflect a greater variety of lights, being compoſed of more various colours.

This variety, which is found in the colour of the eyes, is peculiar to man, and one or two other kinds of animals; but, in general, the colour in any one individual is the ſame in all the reſt. The eyes of oxen are brown; thoſe of ſheep of a water colour; thoſe of goats are grey; " and it may alſo be, in general, remarked, that the eyes of moſt white animals are red; thus the rabbit, the ferrit, and even in the human race, the white Moor, all have their eyes of a red colour."

Although the eye, when put into motion, ſeems to be drawn on one ſide; yet it only moves round its centre; by which its coloured parts moves nearer, or farther from the angle of the eye-lids, or is elevated or depreſſed. The diſtance between the eyes is leſs in man than any other animal; and in ſome of them it is ſo great that, it is impoſſible that they ſhould ever view the ſame object with both eyes at once, unleſs it be very far off. "This, however, in them is rather an advantage than an inconvenience; as they are thus able to watch round them, and guard againſt the dangers of their precarious ſituation."

Next to the eyes, the features, which moſt give a character to the face, are the eye-brows; which being, in ſome meaſure, more apparent than the other features, are moſt readily diſtinguiſhed at a diſtance. "Le Brun, in giving a painter directions, with regard to the paſſions, places the principal expreſſion of the face in the eye-brows. From their elevation and depreſſion, moſt of the furious paſſions are characterized; and ſuch as have this feature extremely moveable, are uſually known to have an expreſſive face. By means of theſe we can imitate all the other paſſions, as they are raiſed and depreſſed, at command; the reſt of the features are generally fixed; or, when put into motion, they do not obey the will; the mouth and eyes, in an actor, for inſtance, may, by being violently diſtorted, give a very different expreſſion from what he would intend; but the eye-brows can ſcarcely be exerted improperly; their being raiſed, denotes all thoſe paſſions which pride or pleaſure inſpire; and their depreſſion marks thoſe which are the effects of contemplation and pain; and ſuch who have this feature, therefore, moſt at command, are often found to excel as actors."

The eye-laſhes have an effect, in giving expreſſion to the eye, particularly when long and cloſe; they ſoften its glances, and improve its ſweetneſs. Man and apes are the only animals that have eye-laſhes both upon the upper and lower lids; all other animals want them on the lid below.

The eye-lids ſerve to guard the ball of the eye, and to furniſh it with a proper moiſture. The upper lid riſes and falls; the lower has ſcarce any motion; and although their being moved depends on the will, yet it often happens that the will is unable to keep them open, when ſleep, or fatigue, oppreſſes the mind. In birds, and amphibious quadrupeds, the lower lid alone has motion; fiſhes and inſects have no eye-lids whatever.

The forehead makes a large part of the face, and a part which chiefly contributes to its beauty. It ought to be juſtly proportioned; neither too round nor too flat; neither too narrow nor too low; and the hair ſhould come thick upon its extremities. It is known to every body how much the hair tends to improve the face; and how much the being bald ſerves to take away from beauty. The higheſt part of the head is that which becomes bald the ſooneſt, as well as that part which lies immediately above the temples. The hair under the temples, and at the back of the head, is very ſeldom known to fail, " and women are much leſs apt to become bald than men; Mr. Buffon ſeems to think they never become bald at all; but we have too many inſtances of the contrary among us, not to contradict very eaſily the aſſertion. Of all parts, or appendages of the body, the hair is that which is found moſt different, in different climates; and often not only contributes to mark the country, but alſo the diſpoſition of the man. It is in general thickeſt where the conſtitution is ſtrongeſt; and more gloſſy and beautiful, where the health is moſt permanent. The ancients held the hair to be a ſort of excrément, produced like the nails; the part next the root puſhing out that immediately contiguous. But the moderns have found that every hair may be truly ſaid to live, to receive nutriment, to fill and diſtend itſelf like the other parts of the body. The roots, they obſerve, do not turn grey ſooner than the extremities, but the whole hair changes colour at once; and we have many inſtances of perſons who have grown grey in one night's time*. Each hair, if viewed with a microſcope, is found to conſiſt of five or ſix leſſer ones, all wrapped up in one common covering; it appears knotted, like ſome ſorts of graſs, and ſends forth branches at the joints. It is bulbous at the root, by which it imbibes its moiſture from the body, and it is ſplit at the points; ſo that a ſingle hair, at its end, reſembles a bruſh. Whatever be the ſize, or the ſhape of the pore, through which the hair iſſues, it accommodates itſelf to the ſame; being either thick, as they are large; ſmall, as they are leſs; round, triangular, and variouſly formed as the pores happen to be various. The hair takes its colour from the juices flowing through it; and it is found that this colour differs in different tribes and races of people. The Americans, and the Aſiatics, have their hair black, thick, ſtraight, and ſhining. The inhabitants of the torrid climates of Africa have its black, ſhort, and woolly. The people of Scandinavia have it red, long, and curled; and thoſe of our own, and the neighbouring countries, are found with hair of various colours. However, it is ſuppoſed by many, that every man reſembles in his diſpoſition the inhabitants of thoſe countries whom he reſembles in the colour, and the nature of his hair; ſo that the black are ſaid, like the Aſiatics, to be grave and acute; the red, like the Gothic nations, to be choleric and bold. However, this may be, the length and the ſtrength of the hair is a general mark of a good conſtitution; and as that hair which is ſtrongeſt is moſt commonly curled, ſo curled hair is generally regarded among us as a beauty. The Greeks, however, had a very different idea of beauty, in this reſpect; and ſeem to have taken one of their peculiar national diſtinctions from the length and the ſtraightneſs of the hair,

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* Mr. Buffon ſays, that the hair begins to grow grey at the points, but the fact is otherwiſe.

The noſe is the moſt prominent feature in the face; but, as it has ſcarce any motion, and that only in the ſtrongeſt paſſions, it rather adds to the beauty than to the expreſſion of the countenance. "However, I am told, by the ſkilful in this branch of knowledge, that wide noſtrils add a great deal to the bold and reſolute air of the countenance; and where they are narrow, though it may conſtitute beauty, it ſeldom improves expreſſion." The form of the noſe, and its advanced poſition, are peculiar to the human viſage alone. Other animals, for the moſt part, have noſtrils, with a partition between them; but none of them have an elevated noſe. Apes themſelves have ſcarce any thing elſe of this feature, but the noſtrils; the reſt of the feature lying flat upon the viſage, and ſcarce higher than the cheek-bones. "Among all the tribes of ſavage men alſo, the noſe is very flat; and I have ſeen a Tartar who had ſcarce any thing elſe but two holes through which to breathe."

The mouth and lips, next to the eyes, are found to have the greateſt expreſſion. The paſſions have great power over this part of the face; and the mouth marks its different degrees, by its different forms. The organ of ſpeech ſtill more animates this part, and gives it more life than any other feature in the countenance. The ruby colour of the lips, and the white enamel of the teeth, give it ſuch a ſuperiority over every other feature, that it ſeems to make the principal object of our regard. In fact, the whole attention is fixed upon the lips of the ſpeaker; however rapid his diſcourſe, however various the ſubject, the mouth takes correſpondent ſituations; and deaf men have been often found to ſee the force of thoſe reaſonings which they could not hear, underſtanding every word as it was ſpoken.

"The under jaw in man poſſeſſes a great variety of motions; while the upper has been thought, by many, to be quite immoveable*. However, that is moves in man, a very eaſy experiment will ſuffice to convince us. If we keep the head fixed, with any thing between our teeth, the edge of a table for inſtance, and then open our mouths, we ſhall find that both jaws recede from it at the ſame time; the upper jaw riſes, and the lower falls, and the table remains untouched between them. The upper jaw, has motion as well as the under; and, what is remarkable, it has its proper muſcles behind the head, for thus raiſing and depreſſing it. Whenever, therefore, we eat, both jaws move at the ſame time, though very unequally; for the whole head moving with the upper jaw, of which it makes a part, its motions are thus leſs obſervable." In the human embryo, the under jaw is very much advanced before the upper. "In the adult, it hangs a good deal more backward; and thoſe whoſe upper and under row of teeth are equally prominent, and ſtrike directly again each other, are what the painters call under-hung; and they conſider this as a great defect in beauty†. The under jaw in a Chineſe face falls greatly more backward than with us; and, I am told, the difference is half an inch, when the mouth is ſhut naturally." In inſtances of the moſt violent paſſion, the under jaw has often an involuntary quivering motion; and often alſo, a ſtate of languor produces another, which is that of yawning. "Every one knows how very ſympathetic this kind of lan-

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[*] Mr. Buffon is of this opinion. He ſays, that the upper jaw is immoveable in all animals. However, the parrot is an obvious exception; and ſo is man himſelf, as ſhewn above.

[†] Mr. Buffon ſays, that both jaws, in a perfect face, ſhould be on a level: but this is denied by the beſt painters.

guid motion is: and that for one perſon to yawn, is ſufficient to ſet all the reſt of the company a yawning. A ridiculous inſtance of this was commonly practiſed upon the famous M'Laurin, one of the profeſſors at Edinburgh. He was very ſubject to have his jaw diſlocated; ſo that when he opened his mouth wider than ordinary, or when he yawned, he could not ſhut it again. In the midſt of his harangues, therefore, if any of his pupils began to be tired of his lecture, he had only to gape or yawn, and the profeſſor inſtantly caught the ſympathetic affection; ſo that he thus continued to ſtand ſpeechleſs, with his mouth wide open, till his ſervant, from the next room, was called in to ſet his jaw again*."

When the mind reflects with regret upon ſome good unattained or loſt, it feels an internal emotion, which acting upon the diaphragm, and that upon the lungs, produces a a ſigh; this, when the mind is ſtongly affected, is repeated; ſorrow ſucceeds theſe firſt emotions; and tears are often ſeen to follow: ſobbing is the ſigh ſtill more invigorated; and lamentation, or crying, proceeds from the continuance of the plaintive tone of the voice, which ſeems to implore pity. "There is yet a ſilent agony, in which the mind appears to diſdain all external help, and broods over its diſtreſſes with gloomy reſerve. This is the moſt dangerous ſtate of mind; accidents or friendſhip may leſſen the louder kinds of grief; but all remedies for this, muſt be had from within: and there, deſpair too often finds the moſt deadly enemy."

Laughter is a ſound of the voice, interrupted and purſued for ſome continuance. The muſcles of the belly, and the diaphragm, are employed in its ſlighteſt exertions; but thoſe of the ribs are ſtrongly agitated in the louder: and the head ſometimes is thrown backward, in order to raiſe them with greater eaſe. The ſmile is often an indication of kindneſs and good will: it is alſo often uſed as a mark of contempt and ridicule.

Bluſhing proceeds from different paſſions; being produced by ſhame, anger, pride, and joy. Paleneſs is often alſo the effect of anger; and almoſt ever attendant on fright and fear. Theſe alterations in the colour of the countenance, are entirely involuntary; all the other expreſſions of the paſſions are, in ſome ſmall degree, under controul; but bluſhing and paleneſs, betray our ſecret purpoſes; and we might as well attempt to ſtop them, as the circulation of the blood, by which they are cauſed.

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* Since the publication of this work, the editor has been credibly informed, that the profeſſer had not the defect here mentioned.

The whole head, as well as the features of the face, takes peculiar attitudes from its paſſions: it bends forward to expreſs humility, ſhame or ſorrow; it is turned to one ſide, in languor, or in pity; it is thrown with the chin forward, in arrogance and pride; erect in ſelf conceit, and obſtinacy; it is thrown backwards in aſtoniſhment; and combines its motions to the one ſide, and the other, to expreſs contempt, ridicule, anger, and reſentment. "Painters, whoſe ſtudy leads to the contemplation of external forms, are much more adequate judges of theſe than any naturaliſt can be; and it is with theſe a general remark, that no one paſſion is regularly expreſſed on different countenances in the ſame manner; that grief often ſits upon the face like joy; and pride aſſumes the air of paſſion. It would be vain, therefore, in words, to expreſs their general effect, ſince they are often as various as the countenances they ſit upon; and in making this diſtinction nicely, lies all the ſkill of the phyſiognomiſt. It being able to diſtinguiſh what part of the face is marked by Nature, and what by the mind; what part has been originally formed, and what is made by habit, conſtitutes this ſcience; upon which the ancients ſo much valued themſelves, and which we at preſent ſo little regard. Some, however, of the moſt acute men among us, have paid great attention to this art; and, by long practice, have been able to give ſome character of every perſon whoſe face they examined. Montaigne is well known to have diſliked thoſe men who ſhut one eye in looking upon any object; and Fielding aſſerts, that he never knew a perſon with a ſteady glavering ſmile, but he found him a rogue. However, moſt of theſe obſervations, tending to a diſcovery of the mind by the face, are merely capricious; and Nature has kindly hid our hearts from each other, to keep us in good humour with our fellow creatures."

The parts of the head which give the leaſt expreſſion to the face, are the ears; and they are generally found hidden under the hair. Theſe, which are immoveable, and make ſo ſmall an appearance in man, are very diſtinguiſhing features in quadrupeds. They ſerve in them as the principal marks of the paſſion; the ears diſcover their joys or their terrors, with tolerable preciſion; and denote all their internal agitations. The ſmalleſt ears, in men, are ſaid to be the moſt beautiful; but the largeſt are found to be the beſt for hearing. There are ſome ſavage nations who bore their ears, and ſo draw that part down, that the tips of the ears are ſeen to reſt upon their ſhoulders.

The ſtrange variety in the different cuſtoms of men appears ſtill more extravagant in their manner of wearing their beards. Some, and among others, the Turks, cut the hair off their heads, and let their beards grow. The Europeans, on the contrary, ſhave their beards, and wear their hair. The Negroes ſhave their heads in figures at one time, in ſtars at another, in the manner of friars; and ſtill more commonly in alternate ſtripes; and their little boys are ſhaved in the ſame manner. The Talapoins of Siam, ſhave the heads and the eye-brows of ſuch children as are committed to their care. Every nation ſeems to have entertained different prejudices, at different times, in favour of one part or another of the beard. Some have admired the hair upon the cheeks on each ſide, as we ſee with ſome low-bred men among ourſelves, who want to be fine. Some like the hair lower down; ſome chooſe it curled; and others like it ſtraight. "Some have cut it into a peak; and others ſhave all but the whiſker. This particular part of the beard was highly prized among the Spaniards; till, of late, a man without whiſkers was conſidered as unfit for company; and where Nature had denied them, Art took care to ſupply the deficiency. We are told of a Spaniſh general who, when he borrowed a large ſum of money from the Venetians, pawned his whiſker, which he afterwards took proper care to releaſe. Kingſon aſſures us, that a conſiderable part of the religion of the Tartars conſiſts in the management of their whiſkers; and that they waged a long and bloody war with the Perſians, declaring them infidels, merely becauſe they would not give their whiſkers the orthodox cut. The kings of Perſia carried the care of their beards to a ridiculous exceſs, when they choſe to wear them matted with gold-thread: and even the kings of France, of the firſt races, had them knotted and buttoned with gold. But of all nations, the Americans take the greateſt pains in cutting their hair, and plucking their beards. The under part of the beard, and all but the whiſker, they take care to pluck up by the roots, ſo that many have ſuppoſed them to have no hair naturally growing on that part; and even Linnæus has fallen into that miſtake. Their hair is alſo cut into bands; and no ſmall care employed in adjuſting the whiſker. In fact, we have a very wrong idea of ſavage finery; and are apt to ſuppoſe that like the beaſts of the foreſt, they riſe, and are dreſſed with a ſhake: but the reverſe is true; for no birth-night beauty takes more time or pains in the adorning her perſon than they. I remember when the Cherokee kings were over here, that I have waited for three hours, during the time they were dreſſing. They never would venture to make their appearance till they had gone through the tedious ceremonies of the toilet; they had their boxes of oil and ochre, their fat and their perfumes, like the moſt effeminate beau, and generally took up four hours in dreſſing, before they conſidered themſelves as fit to be ſeen. We muſt not, therefore, conſider a delicacy in point of dreſs, as a mark of refinement, ſince ſavages are much more difficult in this particular than the moſt faſhionable or tawdry European. The more barbarous the people, the fonder of finery. In Europe, the luſtre of jewels, and the ſplendour of the moſt brilliant colours, are generally given up to women, or to the weakeſt part of the other ſex, who are willing to be contemptibly fine: but in Aſia, theſe trifling fineries are eagerly ſought after by every condition of men; and, as the proverb has it, we find the richeſt jewels in an Æthiop's ear. The paſſion for glittering ornaments is ſtill ſtronger among the abſolute barbarians, who often exchange their whole ſtock of proviſions, and whatever elſe they happen to be poſſeſſed of, with our ſeamen, for a glaſs-bead, or a looking-glaſs."

Although faſhions have ariſen in different countries from fancy and caprice, theſe, when they become general, deſerve examination. Mankind have always conſidered it as a matter of moment, and they will ever continue deſirous of drawing the attention of each other, by ſuch ornaments as mark the riches, the power, or the courage of the wearer. The value of thoſe ſhining ſtones which have at all times been conſidered as precious ornaments, is entirely founded upon their ſcarceneſs or their brilliancy. It is the ſame likewiſe with reſpect to thoſe ſhining metals, the weight of which is ſo little regarded, when ſpread over our clothes. Theſe ornaments are rather deſigned to draw the attention of others, than to add to any enjoyments of our own; and few there are that theſe ornaments will not ſerve to dazzle, and who can coolly diſtinguiſh between the metal and the man.

All things rare and brilliant, will, therefore, ever continue to be faſhionable, while men derive greater advantage from opulence than virtue; while the means of appearing conſiderable, are more eaſily acquired, than the title to be conſidered. The firſt impreſſion we generally make, ariſes from our dreſs; and this varies, in conformity to our inclinations, and the manner in which we deſire to be conſidered. The modeſt man, or he who would wiſh to be thought ſo, deſires to ſhew the ſimplicity of his mind, by the plainneſs of his dreſs; the vain man, on the contrary, takes a pleaſure in diſplaying his ſuperiority, "and is willing to incur the ſpectator's diſlike, ſo he does but excite his attention."

Another point of view which men have in dreſſing, is to increaſe the ſize of their figure; and to take up more room in the world than Nature ſeems to have allotted them. We deſire to ſwell out our clothes by the ſtiffneſs of art, and raiſe our heels, while we add to the largeneſs of our heads. How bulky ſoever our dreſs may be, our vanities are ſtill more bulky. The largeneſs of the doctor's wig ariſes from the ſame pride with the ſmallneſs of the beau's queue. Both want to have the ſize of their underſtanding meaſured by the ſize of their heads.

There are ſome modes that ſeem to have a more reaſonable origin, which is to hide or to leſſen the defects of Nature. To take men altogether, there are many more deformed and plain, than beautiful and ſhapely. The former, as being the moſt numerous, give law to faſhion; and their laws are generally ſuch as are made in their own favour. The women begin to colour their cheeks with red, when the natural roſes are faded; and the younger are obliged to ſubmit, though not compelled by the ſame neceſſity. In all parts of the world, this cuſtom prevails more or leſs; and powdering and frizling the hair, though not ſo general, ſeem to have ariſen from a ſimilar control.

But leaving the draperies of the human picture, let us return to the figure, unadorned by Art. Man's head, whether conſidered externally or internally, is differently formed from that of all other animals, the monkey-kind only excepted, in which there is a ſtriking ſimilitude. There are ſome differences, however, which we ſhall take notice of in another place. The bodies of all quadruped animals are covered with hair; but the head of man ſeems the part moſt adorned; and that more abundantly than in any other animal.

There is a very great variety in the teeth of all animals; ſome have them above and below; others have them in the under jaw only: in ſome they ſtand ſeparate from each other; while in ſome they are continued and united. The palate of ſome fiſhes is nothing elſe but a bony plate ſtudded with points, which perform the offices of teeth. All theſe ſubſtances, in every animal, derive their origin from the nerves; the ſubſtance of the nerves hardens by being expoſed to the air; and the nerves that terminate in the mouth, being thus expoſed, acquire a bony ſolidity. In this manner, the teeth and nails are formed in man; and in this manner alſo, the beak, the hoofs, the horns, and the talons of other animals, are found to be produced.

The neck ſupports the head, and unites it to the body. This part is much more conſiderable in the generality of quadrupeds, than in man. But fiſhes and other animals that want lungs ſimilar to ours, have no neck whatſoever. Birds, in general, have the neck longer than any other kind of animals: thoſe of them, which have ſhort claws, have alſo ſhort necks; thoſe, on the contrary, that have them long, are found to have the neck in proportion. "In men, there is a lump upon the wind-pipe, formed by the thyroid cartilage, which is not to be ſeen in women; an Arabian fable ſays, that this is a part of the original apple, that has ſtuck in the man's throat by the way, but that the woman ſwallowed her part of it down."

The human breaſt is outwardly formed in a very different manner from that of other animals. It is larger in proportion to the ſize of the body; and none but man, and ſuch animals as make uſe of their fore-feet as hands, ſuch as monkies, bats, and ſquirrels, are found to have thoſe bones called the *clavicles*, or, as we uſually term them, the *collar-bones* *. The breaſts in women are larger than in men; however, they ſeem formed in the ſame manner; and, ſometimes, milk is found in the breaſts of man, as well as in thoſe of women. Among animals, there is a great variety in this part of the body. The teats of ſome, as in the ape and the elephant, are like thoſe of men, being but two, and placed on each ſide of the breaſt. The teats of the bear amount to four. The ſheep has but two, placed between the hinder legs. Other animals, ſuch as the bitch, and the ſow, have them all along the belly; and, as they produce many young, they have a great many teats for their ſupport. The form alſo of the teats, varies in different animals; and, in the ſame animal, at different ages. The boſom in females, ſeems to unite all our ideas of beauty, where the outline is continually changing, and the gradations are ſoft and regular.

"The graceful fall of the ſhoulders, both in man and woman, conſtitute no ſmall part of beauty. In apes, though, otherwiſe made like us, the ſhoulders are high, and drawn up on each ſide towards the ears. In man they fall by a gentle declivity; and the more ſo, in proportion to the beauty of his form. In fact, being high-ſhouldered, is not without reaſon conſidered as a deformity, for we find very ſickly perſons are always ſo; and people when dying are ever ſeen with their ſhoulders drawn up in a ſurpriſing manner. The muſcles that ſerve to raiſe the ribs, moſtly riſe near the ſhoulders; and the higher we raiſe the ſhoulders, we the more eaſily raiſe the ribs likewiſe. It happens, therefore, in the ſickly, and the dying, who do not breathe without labour, that to raiſe the ribs, they are obliged to call in the aſſiſtance of the ſhoulders; and thus their bodies aſſume from habit, that form which they are ſo frequently obliged to aſſume. Women with child alſo, are uſually ſeen to be high-ſhouldered; for the weight of the inferior parts drawing down the ribs, they are obliged to uſe every effort to elevate them, and thus they raiſe the ſhoulders of courſe. During pregnancy, alſo, the ſhape, not only of the ſhoulders, but alſo of the breaſt, and even the features of the face, are greatly altered; for the whole upper fore-part of the body is covered with a broad thin ſkin, called the myoides; which being, at that time, drawn down, it alſo draws down with it the ſkin, and, conſequently, the features of the face. By theſe means, the viſage takes a particular form; the lower eye-lids, and the corners of the mouth, are drawn downwards; ſo that the eyes are enlarged, and the mouth lengthened: and women, in theſe circumſtances, are ſaid by the midwives, to be *all mouth and eyes.*"

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* Mr. Buffon ſays, that none but monkies have them, but this is an overſight.

The arms of men but very little reſemble the fore-feet of quadrupeds, and much leſs the wings of birds. The ape is the only animal that is poſſeſſed of hands and arms; but theſe are much more rudely faſhioned, and with leſs exact proportion than in men; "the thumb not being ſo well oppoſed to the reſt of the fingers, in their hands, as in ours."

The form of the back is not much different in man from that of other quadruped animals, only that the reins are more muſcular in him, and ſtronger. The buttock, however, in man, is different from that of all other animals whatſoever. What goes by that name in other creatures, is only the upper part of the thigh: man being the only animal that ſupports himſelf perfectly erect, the largeneſs of this part is owing to the peculiarity of his poſition.

Man's feet, alſo are different from thoſe of all other animals, thoſe even of apes not excepted. The foot of the ape is rather a kind of awkward hand; its toes, or rather fingers, are long, and that of the middle longeſt of all. This foot alſo wants the heel, as in man; the ſole is narrower, and leſs adapted to maintain the equilibrium of the body in walking, dancing or running.

The nails are leſs in man than in any other animal. If they were much longer than the extremities of the fingers, they would rather be prejudicial than ſerviceable, and obſtruct the management of the hand. Such ſavages as let them grow long make uſe of them in fleaing animals, in tearing their fleſh, and ſuch like purpoſes; however, though their nails are conſiderably larger than ours, they are by no means to be compared to the hoofs or the claws of other animals. "They may ſometimes be ſeen longer, indeed, than the claws of any animal whatſoever; as we learn that the nails of ſome of the learned men in China are longer than their fingers. But theſe want that ſolidity which might give force to their exertions; and could never, in a ſtate of nature, have ſerved them for annoyance or defence."

There is little known exactly with regard to the proportion of the human figure; and the beauty of the beſt ſtatues is better conceived by obſerving than by meaſuring them. The ſtatues of antiquity, which were at firſt copied after the human form, are now become the models of it; nor is there one man found whoſe perſon approaches to thoſe inimitable performances that have thus, in one figure, united the perfections of many. It is ſufficient to ſay, that, from being at firſt models, they are now become originals; and are uſed to correct the deviations in that form from whence they were taken." I will not, however, pretend to give the proportions of the human body as taken from theſe, there being nothing more arbitrary, and which good painters themſelves ſo much contemn. Some, for inſtance, who have ſtudied after theſe, divide the body into ten times the length of the face, and others into eight. Some pretend to tell us, that there is a ſimilitude of proportion in different parts of the body. Thus, that the hand is the length of the face; the thumb the length of the noſe; the ſpace between the eyes is the breadth of an eye; that the breadth of the thigh, at thickeſt, is double that of the thickeſt part of the leg, and treble the ſmalleſt; that the arms extended are as long as the figure is high; that the legs and thighs are half the length of the figure. All this, however, is extremely arbitrary; and the excellence of a ſhape, or the beauty of a ſtatue, reſults from the attitude and poſition of the whole, rather than any eſtabliſhed meaſurements, begun without experience, and adopted by caprice. In general, it may be remarked, that the proportions alter in every age, and are obviouſly different in the two ſexes. In woman, the ſhoulders are narrower, and the neck proportionably longer than in men. The hips, alſo, are conſiderably larger, and the thighs much ſhorter than in men. Theſe proportions, however, vary greatly at different ages. In infancy the upper parts of the body are much larger than the lower; the legs and thighs do not conſtitute any thing like half the height of the whole figure; in proportion as the child increaſes in age, the inferior parts are found to lengthen; ſo that the body is not equally divided until it has acquired its full growth.

The ſize of men varies conſiderably. Men are ſaid to be tall who are from five feet eight inches to ſix feet high. The middle ſtature is from five feet five to five feet eight: and theſe are ſaid to be of ſmall ſtature who fall under theſe meaſures. "However, it ought to be remarked, that the ſame perſon is always taller when he riſes in the morning, than upon going to bed at night; and ſometimes there is an inch difference; and I have ſeen more. Few perſons are ſenſible of this remarkable variation; and, I am told, it was firſt perceived, in England, by a recruiting officer. He often found that thoſe men whom he had enliſted for ſoldiers, and anſwered to the appointed ſtandard at one time, fell ſhort of it when they came to be meaſured before the colonel, at the head-quarters. This dimunition in their ſize proceeded from the different times of the day, and the different ſtates of the body when they happened to be meaſured. If, as was ſaid, they were meaſured in the morning, after the night's refreſhment, they were found to be commonly half an inch, and very often a whole inch taller than if meaſured after the fatigues of the day; if they were meaſured when freſh in the country, and before a long fatiguing march to the regiment, they were found to be an inch taller than when they arrived at their journey's end. All this is now well known among thoſe who recruit for the army; and the reaſon of this difference of ſtature is obvious. Between all the joints of the back-bone, which is compoſed of ſeveral pieces, there is a glutinous liquor depoſited, which ſerves, like oil in a machine, to give the parts an eaſy play upon each other. This lubricating liquor, or ſynovia, as the anatomiſts call it, is poured in during the ſeaſon of repoſe, and is conſumed by exerciſe and employment; ſo that in a body, after hard labour, there is ſcarce any of it remaining; but all the joints grow ſtiff, and their motion becomes hard and painful. It is from hence, therefore, that the body diminiſhes in ſtature. For this moiſture being drained away, from between the numerous joints of the back-bone, they lie cloſer upon each other; and their whole length is thus very ſenſibly diminiſhed; but ſleep, by reſtoring the fluid, again ſwells the ſpaces between the joints, and the whole is extended to its former dimenſions.

"As the human body is thus often found to differ from itſelf in ſize, ſo it is found to differ in its weight alſo; and the ſame perſon, without any apparent cauſe, is found to be heavier at one time than another. If, after having eaten a hearty dinner, or having drank hard, the perſon ſhould find himſelf thus heavier, it would appear no way extraordinary; but the fact is, the body is very often found heavier ſome hours after eating a hearty meal than immediately ſucceeding it. If, for inſtance, a perſon, fatigued by a hard day's labour, ſhould eat a plentiful ſupper, and then get himſelf weighed upon going to bed; after ſleeping ſoundly, if he is again weighed, he will find himſelf conſiderably heavier than before; and this difference is often found to amount to a pound, or ſometimes to a pound and a half. From whence this adventitious weight is derived is not eaſy to conceive; the body during the whole night, appears rather plentifully perſpiring than imbibing any fluid, rather loſing than gaining moiſture: however, we have no reaſon to doubt but that either by the lungs, or, perhaps, by a peculiar ſet of pores, it is all this time inhaling a quantity of fluid, which thus increaſes the weight of the whole body, upon being weighed the next morning*."

Although the human body is externally more delicate than any of the quadruped kind, it is, notwithſtanding, extremely muſcular; and, perhaps, for its ſize, ſtronger than that of any other animal. If we ſhould offer to compare the ſtrength of the lion with that of man, we ſhould conſider that the claws of this animal give us a falſe idea of its power; we aſcribe to its force what is only the effects of its arms. Thoſe which man has received from Nature are not offenſive; happy had Art never furniſhed him with any more terrible than thoſe which arm the paws of the lion.

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* From this experiment, alſo, the learned may gather upon what a weak foundation the whole doctrine of the Sanctorian perſpiration is built; but this diſquiſition more properly belongs to medicine than natural hiſtory.

But there is another manner* of comparing the ſtrength of man with that of other animals; namely, by the weights which either can carry. We are aſſured that the porters of Conſtantinople carry burdens of nine hundred pounds weight: Mr. Deſaguliers tells us of a man, who, by diſtributing weights in ſuch a manner as that every part of his body bore its ſhare, he was thus able to raiſe a weight of two thouſand pounds. A horſe, which is about ſeven times our bulk, would be thus able to raiſe a weight of fourteen thouſand pounds, if its ſtrength were in the ſame proportion†. "But the truth is, a horſe will not carry upon its back above a weight of two or three hundred pounds; while a man of confeſſedly inferior ſtrength, is thus able to ſupport two thouſand. Whence comes this ſeeming ſuperiority? The anſwer is obvious. Becauſe the load upon man's ſhoulders is placed to the greateſt advantage; while, upon the horſe's back, it is placed at the greateſt diſadvantage. Let us ſuppoſe, for a moment, the man ſtanding as upright as poſſible, under the great load abovementioned. It is obvious that all the bones of his body may be compared to a pillar ſupporting a building, and that his muſcles have ſcarce any ſhare in this dangerous duty. However, they are not entirely inactive; as man, let him ſtand never ſo upright, will have ſome bending in the different parts of his body. The muſcles, therefore, give the bones ſome aſſiſtance, and that with the greateſt poſſible advantage. In this manner, a man has been found to ſupport two thouſand weight; but may be capable of ſupporting a ſtill greater. The manner in which this is done, is by ſtrapping the load round the ſhoulders of the perſon who is to bear it, by a machine, ſomething like that by which milk-veſſels or water-buckets are carried. The load being thus placed on a ſcaffold, on each ſide, contrived for that purpoſe, and the man ſtanding erect in the midſt, all parts of the ſcaffold, except that where the man ſtands, are made to ſink; and thus the man maintaining his poſition, the load, whatever it is, becomes ſuſpended, and the column of his bones may be fairly ſaid to ſupport it. If, however, he ſhould but ever ſo little give way, he muſt inevitably drop; and no power of his can raiſe the weights again. But the caſe is very different with regard to a load laid upon a horſe. The column of the bones there lies a different way; and a weight of five hundred pounds, as I am told, would break the back of the ſtrongeſt horſe that could be found. The great force of a horſe, and other quadrupeds, is exerted when the load is in ſuch a poſition as that the column of the bones can be properly applied, which is lengthwiſe. When, therefore, we are to eſtimate the comparative ſtrength of a horſe, we are not to try what he can carry, but what he can draw; and, in this caſe, his amazing ſuperiority over man is eaſily diſcerned; for one horſe can draw a load that ten men cannot move. And in ſome caſes it happens that a draught-horſe draws the better for being ſomewhat loaded; for, as the peaſants ſay, the load upon the back keeps him the better to the ground."

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* Mr. Buffon calls it a better manner; but this is not the caſe.

† Mr. Buffon carries this ſubject no farther; and thus far, without explanation, it is erroneous.

There is ſtill another way of eſtimating human ſtrength by the perſeverance and agility of our motions. Men, who are exerciſed in running, outſtrip horſes; or, at leaſt, hold their ſpeed for a longer continuance. In a journey, alſo, a man will walk down a horſe; and, after they have both continued to proceed for ſeveral days, the horſe will be quite tired, and the man will be freſher than in the beginning. The king's meſſengers of Iſpahan, who are runners by profeſſion, go thirty-ſix leagues in fourteen hours. Travellers aſſure us, that the Hottentots outſtrip lions in the chace; and that the ſavages, who hunt the elk, purſue with ſuch ſpeed, that they at laſt tire down, and take it. We are told many very ſurpriſing things of the great ſwiftneſs of the ſavages, and of the long journeys they undertake, on foot, through the moſt craggy mountains, where there are no paths to direct, nor houſes to entertain them. They are ſaid to perform a journey of twelve hundred leagues in leſs than ſix weeks. "But notwithſtanding what travellers report of this matter, I have been aſſured, from many of our officers, and ſoldiers, who compared their own ſwiftneſs with that of the native Americans, during the laſt war, that although the ſavages held out, and, as the phraſe is, had better bottoms, yet, for a ſpurt, the Engliſhmen were more nimble and ſpeedy."

Nevertheleſs, in general, civilized man is ignorant of his own powers; he is ignorant how much he loſes by effeminacy; and what might be acquired by habit and exerciſe. Here and there, indeed, men are found among us of extraordinary ſtrength; but that ſtrength, for want of opportunity, is ſeldom called into exertion. "Among the ancients it was a quality of much greater uſe than at preſent; as in war the ſame man that had ſtrength ſufficient to carry the heavieſt armour, had ſtrength ſufficient alſo to ſtrike the moſt fatal blow. In this caſe, his ſtrength was at once his protection and his power. We ought not to be ſurpriſed, therefore, when we hear of one man terrible to an army, and irreſiſtible in his career, as we find ſome generals repreſented in ancient hiſtory. But we may be very certain that this proweſs was exaggerated by flattery, and exalted by terror. An age of ignorance is ever an age of wonder. At ſuch times, mankind, having no juſt ideas of the human powers, are willing rather to repreſent what they wiſh than what they know; and exalt human ſtrength, to fill up the whole ſphere of their limited conceptions. Great ſtrength is an accidental thing; two, or three, in a country, may poſſeſs it; and theſe may have a claim to heroiſm. But what may lead us to doubt of the veracity of theſe accounts is, that the heroes of Antiquity are repreſented as the ſons of heroes; their amazing ſtrength is delivered down from father to ſon; and this we know to be contrary to the courſe of Nature. Strength is not hereditary; although titles are: and I am very much induced to believe, that this great tribe of heroes, who were all repreſented as the deſcendants of heroes, are more obliged to their titles than to their ſtrength, for their characters. With regard to the ſhining characters in Homer, they are all repreſented as princes, and as the ſons of princes; while we are told of ſcarce any ſhare of prowefs in the meaner men of the army; who are only brought into the field for theſe to protect, or to ſlaughter. But nothing can be more unlikely than that thoſe men, who were bred in the luxury of courts, ſhould be ſtrong; while the whole body of the people, who received a plainer and ſimple education, ſhould be comparatively weak. Nothing can be more contrary to the general laws of Nature, than that all the ſons of heroes ſhould thus inherit not only the kingdoms, but the ſtrength of their forefathers; and we may conclude, that they owe the greateſt ſhare of their imputed ſtrength rather to the dignity of their ſtations than the force of their arms; and, like all fortunate princes, their flatterers happened to be believed. In later ages, indeed, we have ſome accounts of amazing ſtrength, which we can have no reaſon to doubt of. But in theſe, Nature is found to purſue her ordinary courſe; and we find their ſtrength accidental. We find theſe ſtrong men among the loweſt of the people, and gradually riſing into notice, as this ſuperiority had more opportunity of being ſeen. Of this number was the Roman tribune, who went by the name of the ſecond Achilles; who, with his own hand, is ſaid to have killed, at different times, three hundred of the enemy; and when treacherouſly ſet upon, by twenty-five of his own countrymen, although then paſt his ſixtieth year, killed fourteen of them before he was ſlain. Of this number was Milo, who, when he ſtood upright, could not be forced out of his place. Pliny, alſo, tells us of one Athanatus, who walked acroſs the ſtage at Rome, loaded with a breaſt-plate weighing five hundred pounds, and buſkins of the ſame weight. But of all the prodigies of ſtrength, of whom we have any accounts in Roman hiſtory, Maximin, the emperor, is to be reckoned the foremoſt. Whatever we are told relative to him is well atteſted; his character was too exalted not to be thoroughly known; and that very ſtrength, for which he was celebrated, at laſt procured him no leſs a reward than the empire of the world. Maximin was above nine feet in height, and the beſt proportioned man in the whole empire. He was by birth a Thracian; and, from being a ſimple herdſman, roſe through the gradations of office, until he came to be Emperor of Rome.

The firſt opportunity he had of exerting his ſtrength, was in the preſence of all the citizens, in the theatre, where he overthrew twelve of the ſtrongeſt men, in wreſtling, and outſtript two of the fleeteſt horſes, in running, all in one day. He could draw a chariot loaden, that two ſtrong horſes could not move; he could break a horſe's jaw with a blow of his fiſt; and its thigh with a kick. In war he was always foremoſt, and invincible; happy had it been for him and, his ſubjects, if, from being formidable to his enemies, he had not become ſtill more ſo to his ſubjects; he reigned, for ſome time, with all the world his enemy; all mankind wiſhing him dead, yet none daring to ſtrike the blow. As if fortune had reſolved that through life he ſhould continue unconquerable, he was killed at laſt by his own ſoldiers, while he was ſleeping. We have many other inſtances, in later ages, of very great ſtrength, and not fewer of amazing ſwiftneſs; but theſe, merely corporeal perfections, are now conſidered as of ſmall advantage, either in war or in peace. The invention of gunpowder has, in ſome meaſure, levelled all force to one ſtandard; and has wrought a total change in martial education through all parts of the world. In peace alſo, the invention of new machines every day, and the application of the ſtrength of the lower animals to the purpoſes of life, have rendered human ſtrength leſs valuable. The boaſt of corporeal force is therefore conſigned to ſavage nations, where thoſe arts not being introduced, it may ſtill be needful; but, in more polite countries, few will be proud of that ſtrength which other animals can be taught to exert to as uſeful purpoſes as they.

"If we compare the largeneſs and thickneſs of our muſcles with thoſe of any other animal, we ſhall find that, in this reſpect, we have the advantage; and if ſtrength, or ſwiftneſs depended upon the quantity of muſcular fleſh alone, I believe that, in this reſpect, we ſhould be more active and powerful than any other. But this is not the caſe; a great deal more than the ſize of the muſcles goes to conſtitute activity, or force; and it is not he who has the thickeſt legs that can make the beſt uſe of them. Thoſe, therefore, who have written elaborate treatiſes on muſcular force, and have eſtimated the ſtrength of animals by the thickneſs of their muſcles, have been employed to very little purpoſe. It is, in general, obſerved that thin and raw-boned men are always ſtronger and more powerful, than ſuch as are ſeemingly more muſcular; as in the former all the parts have better room for their exertions."

Women want much of the ſtrength of men; and, in ſome countries, the ſtronger ſex have availed themſelves of this ſuperiority, in cruelly and tyrannically enſlaving thoſe who were made with equal pretenſions to a ſhare in all the advantages life can beſtow. Savage nations oblige their women to a life of continual labour; upon them reſt all the drudgeries of domeſtic duty; while the huſband, indolently reclined in his hammoc, is firſt ſerved from the fruits of her induſtry. From this negligent ſituation, he is ſeldom rouzed, except by the calls of appetite, when it is neceſſary, either by fiſhing or hunting, to make a variety in his entertainments. A ſavage has no idea of taking pleaſure in exerciſe; he is ſurpriſed to ſee an European walk forward for his amuſement, and then return back again. As for his part he could be contented to remain for ever in the ſame ſituation, perfectly ſatisfied with ſenſual pleaſures and undiſturbed repoſe. The women of theſe countries, are the greateſt ſlaves upon earth; ſenſible of their weakneſs, and unable to reſiſt, they are obliged to ſuffer thoſe hardſhips which are naturally inflicted by ſuch as have been taught that nothing but corporeal force ought to give pre-eminence. It is not, therefore, till after ſome degree of refinement, that women are treated with lenity; and not till the higheſt degree of politeneſs, that they are permitted to ſhare in all the privileges of man. The firſt impulſe of ſavage nature is to confirm their ſlavery; the next of half barbarous nations, is to appropriate their beauty; and that, of the perfectly polite, to engage their affections. In civilized countries, therefore, women have united the force of modeſty to the power of their natural charms; and thus obtain that ſuperiority over the mind, which they are unable to extort by their ſtrength.

CHAP. VI.

OF SLEEP AND HUNGER.

AS man, in all the privileges he enjoys, and the powers he is inveſted with, has a ſuperiority over all other animals, ſo, in his neceſſities, he ſeems inferior to the meaneſt of them all. Nature has brought him into life with a greater variety of wants and infirmities, than the reſt of her creatures, unarmed in the midſt of enemies. The lion has natural arms; the bear natural clothing; but man is deſtitute of all ſuch advantages; and, from the ſuperiority of his mind alone, he is to ſupply the deficiency. The number of his wants, however, were merely given, in order to multiply the number of his enjoyments; ſince the poſſibility of being deprived of any good, teaches him the value of its poſſeſſion. Were men born with thoſe advantages which he learns to poſſeſs by induſtry, he would very probably enjoy them with a blunter reliſh: it is by being naked, that he knows the value of a covering; it is by being expoſed to the weather, that he learns the comforts of a habitation. Every want thus becomes a means of pleaſure, in the redreſſing; and the animal that has moſt deſires, may be ſaid to be capable of the greateſt variety of happineſs.

Beſide the thouſand imaginary wants peculiar to man, there are two, which he has in common with all other animals; and which he feels in a more neceſſary manner than they. Theſe are the wants of ſleep and hunger. Every animal that we are acquainted with, ſeems to endure the want of theſe with much leſs injury to health, than man; and ſome are moſt ſurpriſingly patient in ſuſtaining both. The little domeſtic animals that we keep about us, may often ſet a leſſon of calm reſignation, in ſupporting want and watchfulneſs, to the boaſted philoſopher. They receive their pittance at uncertain intervals, and wait its coming with cheerful expectation. We have inſtances of the dog, and the cat living in this manner, without food, for ſeveral days; and yet ſtill preſerving their attachment to the tyrant that oppreſſes them; ſtill ready to exert their little ſervices for his amuſement or defence. But the patience of theſe is nothing, to what the animals of the foreſt endure. As theſe moſtly live upon accidental carnage, ſo they are often known to remain without food for ſeveral weeks together. Nature, kindly ſolicitous for their ſupport, has alſo contracted their ſtomachs, to ſuit them for their precarious way of living; and kindly, while it abridges the banquet, leſſens the neceſſity of providing for it. But the meaner tribes of animals are made ſtill more capable of ſuſtaining life without food, many of them remaining in a ſtate of torpid indifference till their prey approaches, when they jump upon and ſeize it. In this manner, the ſnake, or the ſpider, continue, for ſeveral months together, to ſubſiſt upon a ſingle meal; and ſome of the butterfly kinds live upon little or nothing. But it is very different with man; his wants daily make their importunate demands; and it is known, that he cannot continue to live many days without eating, drinking, and ſleeping.

Hunger is a much more powerful enemy to man than watchfulneſs, and kills him much ſooner. It may be conſidered as a diſorder that food removes; and that would quickly be fatal, without its proper antidote. In fact, it is ſo terrible to man, that to avoid it he even encounters certain death; and, rather than endure its tortures, exchanges them for immediate deſtruction. However, by what I have been told, it is much more dreadful in its approaches, than in its continuance; and the pains of a famiſhing wretch decreaſe, as his ſtrength diminiſhes. In the beginning, the deſire of food is dreadful indeed, as we know by experience; for there are few who have not, in ſome degree, felt its approaches. But, after the firſt or ſecond day, its tortures become leſs terrible, and a total inſenſibility at length comes kindly in to the poor wretch's aſſiſtance. I have talked with the captain of a ſhip, who was one of ſix that endured it in its extremities; and who was the only perſon that had not loſt his ſenſes, when they received accidental relief. He aſſured me, his pains at firſt were ſo great, as to be often tempted to eat a part of one of the men who died; and which the reſt of his crew actually for ſome time lived upon: he ſaid, that, during the continuance of this paroxyſm, he found his pains inſupportable; and was deſirous, at one time, of anticipating that death which he thought inevitable: but his pains, he ſaid, gradually decreaſed, after the ſixth day, (for they had water in the ſhip, which kept them alive ſo long) and then he was in a ſtate rather of languor than deſire; nor did he much wiſh for food, except when he ſaw others eating; and that for a while revived his appetite, though with diminiſhed importunity. The latter part of the time, when his health was almoſt deſtroyed, a thouſand ſtrange images roſe upon his mind; and every one of his ſenſes began to bring him wrong information. The moſt fragrant perfumes appeared to him to have a fœtid ſmell; and every thing he looked at, took a greeniſh hue, and ſometimes a yellow. When he was preſented with food by the ſhip's company that took him and his men up, four of whom died ſhortly after, he could not help looking upon it with loathing, inſtead of deſire; and it was not till after four days, that his ſtomach was brought to its natural tone; when the violence of his appetite returned, with a ſort of canine eagerneſs.

Thus dreadful are the effects of hunger; and yet when we come to aſſign the cauſe that produces them, we find the ſubject involved in doubt and intricacy. This longing eagerneſs is, no doubt, given for a very obvious purpoſe; that of repleniſhing the body, waſted by fatigue and perſpiration. Were not men ſtimulated by ſuch a preſſing monitor, they might be apt to purſue other amuſements, with a perſeverance beyond their power; and forget the uſeful hours of refreſhment, in thoſe more tempting ones of pleaſure. But hunger makes a demand that will not be refuſed; and, indeed, the generality of mankind ſeldom await the call.

Hunger has been ſuppoſed by ſome to ariſe from the rubbing of the coats of the ſtomach againſt each other; without having any intervening ſubſtance to prevent their painful attrition. Others have imagined, that its juices, wanting their neceſſary ſupply, turn acrid, or, as ſome ſay, pungent; and thus fret its internal coats, ſo as to produce a train of the moſt uneaſy ſenſations. Boerhaave, who eſtabliſhed his reputation in phyſic, by uniting the conjectures of all thoſe that preceded him, aſcribes hunger to the united effect of both theſe cauſes; and aſſerts, that the pungency of the gaſtric juices, and the attrition of its coats againſt each other, cauſe thoſe pains, which nothing but food can remove. Theſe juices continuing ſtill to be ſeparated in the ſtomach, and every moment becoming more acrid, mix with the blood, and infect the circulation: the circulation being thus contaminated, becomes weaker, and more contracted; and the whole nervous frame ſympathiſing, an hectic fever, and ſometimes madneſs, is produced; in which ſtate the faint wretch expires. In this manner, the man who dies of hunger, may be ſaid to be poiſoned by the juices of his own body; and is deſtroyed leſs by the want of nouriſhment, than by the vitiated qualities of that which he had already taken.

However this may be, we have but few inſtances of men dying, except at ſea, of abſolute hunger. The decline of thoſe unhappy creatures who are deſtitute of food, at land, being more ſlow and unperceived. Theſe, from often being in need, and as often receiving an accidental ſupply, paſs their lives between ſurfeiting and repining; and their conſtitution is impaired by inſenſible degrees. Man is unfit for a ſtate of precarious expectation. That ſhare of provident precaution which incites him to lay up ſtores for a diſtant day, becomes his torment, when totally unprovided againſt an immediate call. The lower race of animals, when ſatisfied, for the inſtant moment, are perfectly happy: but it is otherwiſe with man; his mind anticipates diſtreſs, and feels the pangs of want even before it arreſts him. Thus the mind, being continually haraſſed by the ſituation, it at length influences the conſtitution, and unfits it for all its functions. Some cruel diſorder, but no way like hunger, ſeizes the unhappy ſufferer; ſo that almoſt all thoſe men who have thus long lived by chance, and whoſe every day may be conſidered as an happy eſcape from famine, are known at laſt to die in reality, of a diſorder cauſed by hunger; but which, in the common language, is often called a *broken heart.* Some of theſe I have known myſelf, when very little able to relieve them: and I have been told, by a very active and worthy magiſtrate, that the number of ſuch as die in London for want, is much greater than one would imagine—I think he talked of two thouſand in a year!

But how numerous ſoever thoſe who die of hunger may be, many times greater, on the other hand, are the number of thoſe who die by repletion. It is not the province of the preſent page to ſpeculate, with the phyſician, upon the danger of ſurfeits; or with the moraliſt, upon the nauſeouſneſs of gluttony; it will only be proper to obſerve, that as nothing is ſo prejudicial to health as hunger by conſtraint, ſo nothing is more beneficial to the conſtitution than voluntary abſtinence. It was not without reaſon that religion enjoined this duty; ſince it anſwered the double purpoſe of reſtoring the health oppreſſed by luxury, and diminiſhed the conſumption of proviſions, ſo that a part might come to the poor. It ſhould be the buſineſs of the legiſlature, therefore, to enforce this divine precept; and thus, by reſtraining one part of mankind in the uſe of their ſuperfluities, to conſult for the benefit of thoſe who want the neceſſaries of life. The injunctions for abſtinence are ſtrict over the whole Continent; and were rigorouſly obſerved, even among ourſelves, for a long time after the Reformation. Queen Elizabeth, by giving her commands, upon this head the air of a political injuction, leſſened, in a great meaſure, and, in my opinion, very unwiſely, the religious force of the obligation. She enjoined that her ſubjects ſhould faſt from fleſh on Fridays and Saturdays; but at the ſame time declared, that this was not commanded from motives of religion, as if there were any differences in meats, but merely to favour the conſumption of fiſh, and thus to multiply the number of mariners; and alſo to ſpare the ſtock of ſheep, which might be more beneficial in another way. In this manner the injunction defeated its own force; and this moſt ſalutary law became no longer binding, when it was ſuppoſed to come purely from man. How far it may be enjoined in the Scriptures, I will not take upon me to ſay; but this may be aſſerted, that if the utmoſt benefit to the individual, and the moſt extenſive advantage to ſociety, ſerve to mark any inſtitution as of Heaven, this of abſtinence may be reckoned among the foremoſt.

Were we to give an hiſtory of the various benefits that have ariſen from this command, and how conducive it has been to long life, the inſtances would fatigue with their multiplicity. It is ſurpriſing to what a great age the primitive Chriſtians of the Eaſt, who retired from perſecution in the deſerts of Arabia, continued to live, in all the bloom of health, and yet all the rigours of abſtemious diſcipline. Their common allowance, as we are told, for four and twenty hours, was twelve ounces of bread, and nothing but water. On this ſimple beverage, St. Anthony is ſaid to have lived an hundred and five years; James, the hermit, an hundred and four; Arſenius, tutor to the Emperor Arcadius an hundred and twenty; St. Epiphanius, an hundred and fifteen; Simeon, an hundred and twelve; and Rombald, an hundred and twenty. In this manner did theſe holy temperate men live to an extreme old age, kept cheerful by ſtrong hopes, and healthful by moderate labour.

Abſtinence which is thus voluntary, may be much more eaſily ſupported than conſtrained hunger. Man is ſaid to live without food for ſeven days; which is the uſual limit aſſigned him: and, perhaps, in a ſtate of conſtraint, this is the longeſt time he can ſurvive the want of it. But in caſes of voluntary abſtinence, of ſickneſs, or ſleeping, he has been known to live much longer.

In the records of the Tower, there is an account of a Scotchman, impriſoned for felony, who, for the ſpace of ſix weeks, took not the leaſt ſuſtenance, being exactly watched during the whole time; and for this he received the king's pardon.

When the American Indians undertake long journies, and when, conſequently, a ſtock of proviſions ſufficient to ſupport them the whole way, would be more than they could carry, in order to obviate this inconvenience, inſtead of carrying the neceſſary quantity, they contrive a method of palliating their hunger, by ſwallowing pills, made of calcined ſhells and tobacco. Theſe pills take away all appetite, by producing a temporary diſorder in the ſtomach; and, no doubt, the frequent repetition of this wretched expedient, muſt at laſt be fatal. By this means, however, they continue ſeveral days without eating, cheerfully bearing ſuch extremes of fatigue and watching, as would quickly deſtroy men bred up in a greater ſtate of delicacy. For thoſe arts by which we learn to obviate our neceſſities, do not fail to unfit us for their accidental encounter.

Upon the whole, therefore, man is leſs able to ſupport hunger than any other animal; and he is not better qualified to ſupport a ſtate of watchfulneſs. Indeed, ſleep ſeems much more neceſſary to him, than to any other creature: as, when awake, he may be ſaid to exhauſt a greater proportion of the nervous fluid; and, conſequently, to ſtand in need of an adequate ſupply. Other animals, when moſt awake, are but little removed from a ſtate of ſlumber; their feeble faculties, impriſoned in matter, and rather exerted by impulſe than deliberation, require ſleep rather as a ceſſation from motion, than from thinking. But it is otherwiſe with man; his ideas, fatigued with their various excurſions, demand a ceſſation, not leſs than the body, from toil; and he is the only creature that ſeems to require ſleep from double motives; not leſs for the refreſhment of the mental, than of the bodily frame.

There are ſome lower animals, indeed, that ſeem to ſpend the greateſt part of their lives in ſleep; but, properly ſpeaking, the ſleep of ſuch may be conſidered as a kind of death; and their waking, a reſurrection. Flies and inſects, are ſaid to be a ſleep, at a time that all the vital motions have ceaſed; without reſpiration, without any circulation of their juices, if cut in piees, they do not awake, nor does any fluid ooze out at the wound. Theſe may be conſidered rather as congealed than as ſleeping animals; and their reſt, during winter, rather as a ceſſation from life, than a neceſſary refreſhment: but in the higher races of animals, whoſe blood is not thus congealed, and thawed by heat, theſe all bear the want of ſleep much better than man; and ſome of them continue a long time without ſeeming to take any refreſhment from it whatſoever.

But man is more feeble; he requires its due return; and if it fails to pay the accuſtomed viſit, his whole frame is in a ſhort time thrown into diſorder; his appetite ceaſes; his ſpirits are dejected; his pulſe becomes quicker and harder; and his mind, abridged of its ſlumbering viſions, begins to adopt waking dreams. A thouſand ſtrange phantoms ariſe, which come and go without his will: theſe, which are tranſient in the beginning, at laſt take firm poſſeſſion of the mind, which yields to their dominion, and, after a long ſtruggle, runs into confirmed madneſs. In that horrid ſtate, the mind may be conſidered as a city without walls, open to every inſult, and paying homage to every invader: every idea that then ſtarts with any force, becomes a reality; and the reaſon, over fatigued with its former importunities, makes no head againſt the tyranical invaſion, but ſubmits to it from mere imbecility.

But it is happy for mankind, that this ſtate of inequietude is ſeldom driven to an extreme; and that there are medicines, which ſeldom fail to give relief. However, man finds it more difficult than any other animal to procure ſleep: and ſome are obliged to court its approaches for ſeveral hours together, before they incline to reſt. It is in vain that all light is excluded; that all ſounds are removed; that warmth and ſoftneſs conſpire to invite it; the reſtleſs and buſy mind ſtill retains its former activity; and Reaſon, that wiſhes to lay down the reins, in ſpite of herſelf, is obliged to maintain them. In this diſagreeable ſtate, the mind paſſes from thought to thought, willing to loſe the diſtinctneſs of perception, by increaſing the multitude of the images. At laſt, when the approaches of ſleep are near, every object of the imagination begins to mix with that next it; their outlines become, in a manner, rounder; a part of their diſtinctions fade away; and ſleep, that enſues, faſhions out a dream from the remainder.

If then it ſhould be aſked from what cauſe this ſtate of repoſe proceeds, or in what manner ſleep thus binds us for ſeveral hours together, I muſt fairly confeſs my ignorance; although it is eaſy to tell what philoſophers ſay upon the ſubject. Sleep, ſays one of them*, conſiſts in a ſcarcity of ſpirits, by which the orifices or pores of the nerves in the brain, through which the ſpirits uſed to flow into the nerves, being no longer kept open by the frequency of the ſpirits, ſhut of themſelves; thus the nerves, wanting a new ſupply of ſpirits, become lax, and unfit to convey any impreſſion to the brain. All this, however, is explaining a very great obſcurity by ſomewhat more obſcure: leaving, therefore, thoſe ſpirits to open and ſhut the entrances to the brain, let us be contented with ſimply enumerating the effects of ſleep upon the human conſtitution.

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* Rohault.

In ſleep, the whole nervous frame is relaxed, while the heart and the lungs ſeem more forcibly exerted. This fuller circulation produces alſo a ſwelling of the muſcles, as they always find who ſleep with ligatures on any part of their body. This increaſed circulation alſo, may be conſidered as a kind of exerciſe, which is continued through the frame; and, by this, the perſpiration becomes more copious, altho' the appetite for food is entirely taken away. Too much ſleep dulls the apprehenſion, weakens the memory, and unfits the body for labour. On the contrary, ſleep too much abridged, emaciates the frame, produces melancholy, and and conſumes the conſtitution. It requires ſome care, therefore, to regulate the quantity of ſleep, and juſt to take as much as will completely reſtore Nature, without oppreſſing it. The poor, as Otway ſays, ſleep little; forced, by their ſituation, to lengthen out their labour to their neceſſities, they have but a ſhort interval for this pleaſing refreſhment; and I have ever been of opinion, that bodily labour demands a leſs quantity of ſleep than mental. Labourers and artizans are generally ſatisfied with about ſeven hours; but I have known ſome ſcholars who uſually ſlept nine, and perceived their faculties no way impaired by overſleeping.

The famous Philip Barrettiere, who was conſidered as a prodigy of learning at the age of fourteen, was known to ſleep regularly twelve hours in the twenty-four; the extreme activity of his mind, when awake, in ſome meaſure called for an adequate alternation of repoſe: and, I am apt to think, that when ſtudents ſtint themſelves in this particular, they leſſen the waking powers of the imagination, and weaken its moſt ſtrenuous exertions. Animals that ſeldom think, as was ſaid, can very eaſily diſpenſe with ſleep; and of men, ſuch as think leaſt, will, very probably, be ſatisfied with the ſmalleſt ſhare. A life of ſtudy, it is well known, unfits the body for receiving this gentle refreſhment; the approaches of ſleep are driven off by thinking: when, therefore, it comes at laſt, we ſhould not be too ready to interrupt its continuance.

Sleep is, indeed, to ſome, a very agreeable period of their exiſtence: and it has been a queſtion in the ſchools, which was moſt happy, the man who was a beggar by night, and a king by day; or he who was a beggar by day, and a king by night? It is given in favour of the nightly monarch, by him who firſt ſtarted the queſtion: "For the dream," ſays he, "gives the full enjoyment of the dignity, without its attendant inconveniences; while, on the other hand, the king, who ſuppoſes himſelf degraded, feels all the miſery of his fallen fortune, without trying to find the comforts of his humble ſituation. Thus, by day, both ſtates have their peculiar diſtreſſes: but, by night, the exalted beggar is perfectly bleſſed, and the king completely miſerable." All this, however, is rather fanciful than juſt; the pleaſure dreams can give us, ſeldom reaches to our waking pitch of happineſs: the mind often, in the midſt of its higheſt viſionary ſatisfactions, demands of itſelf, whether it does not owe them to a dream; and frequently awakes with the reply.

But it is ſeldom, except in caſes of the higheſt delight, or the moſt extreme uneaſineſs, that the mind has power thus to diſengage itſelf from the dominion of fancy. In the ordinary courſe of its operations, it ſubmits to thoſe numberleſs phantaſtic images that ſucceed each other, and which, like many of our waking thoughts, are generally forgotten. Of theſe, however, if any, by their oddity, or their continuance, affect us ſtrongly, they are then remembered; and there have been ſome who felt their impreſſions ſo ſtrongly, as to miſtake them for realities, and to rank them among the paſt actions of their lives.

There are others upon whom dreams ſeem to have a very different effect; and who, without ſeeming to remember their impreſſions the next morning, have yet ſhewn, by their actions during ſleep, that they were very powerfully impelled by their dominion. We have numberleſs inſtances of ſuch perſons, who, while aſleep, have performed many of the ordinary duties to which they have been accuſtomed when waking; and, with a ridiculous induſtry, have completed by night, what they failed doing by day. We are told in the German Ephemerides, of a young ſtudent, who being enjoined a ſevere exerciſe by his tutor, went to bed, deſpairing of accompliſhing it. The next morning awaking, to his great ſurpriſe he found the taſk fairly written out, and finiſhed in his own hand-writing. He was at firſt, as the account has it, induced to aſcribe this ſtrange production to the operation of an infernal agent; but his tutor, willing to examine the affair to the bottom, ſet him another exerciſe, ſtill more ſevere than the former, and took precautions to obſerve his conduct the whole night. The young gentleman, upon being ſo ſeverely taſked, felt the ſame inquietude that he had done on the former occaſion; went to bed gloomy and penſive, pondering on the next day's duty, and, after ſome time, fell aſleep. But ſhortly after, his tutor, who continued to obſerve him from a place that was concealed, was ſurpriſed to ſee him get up, and very deliberately go to the table; where he took out pen, ink, and paper, drew himſelf a chair, and ſat very methodically to thinking: it ſeems, that his being aſleep, only ſerved to ſtrengthen the powers of his imagination; for he very quickly and eaſily went through the taſk aſſigned him, put his chair aſide, and then returned to bed to take out the reſt of his nap. What credit we are to give to this account, I will not pretend to determine: but this may be ſaid, that the book from whence it is taken, has ſome good marks of veracity; for it is very learned, and very dull; and is written in a country noted, if not for truth, at leaſt for want of invention.

The ridiculous hiſtory of Arlotto is well-known, who has had a volume written, containing a narrative of the actions of his life, not one of which was performed while he was awake. He was an Italian Franciſcan friar, extremely rigid in his manners, and remarkably devout and learned in his daily converſation. By night, however, and during his ſleep, he played a very different character from what he did by day, and was often detected in very atrocious crimes. He was at one time detected in actually attempting a rape, and did not awake till the next morning, when he was ſurpriſed to find himſelf in the hands of juſtice. His brothers of the convent often watched him while he went very deliberately into the chapel, and there attempted to commit ſacrilege. They ſometimes permitted him to carry the chalice and the veſtments away into his own chamber, and the next morning amuſed themſelves at the poor man's conſternation for what he had done. But of all his ſleeping tranſgreſſions, that was the moſt ridiculous, in which he was called to pray for the ſoul of a perſon departed. Arlotto, after having devoutly performed his duty, retired to a chamber which was ſhewn him to reſt; but there he had no ſooner fallen aſleep, than he began to reflect that the dead body had got a ring upon one of the fingers, which might be uſeful to him: accordingly, with a pious reſolution of ſtealing it, he went down, undreſſed as he was, into a room full of women, and, with great compoſure, endeavoured to ſeize the ring. The conſequence was that he was taken before the Inquiſition for witchcraft; and the poor creature had like to have been condemned, till his peculiar character accidentally came to be known: however, he was ordered to remain for the reſt of life in his own convent, and upon no account whatſoever to ſtir abroad.

What are we to ſay of ſuch actions as theſe; or how account for this operation of the mind in dreaming? It ſhould ſeem, that the imagination, by day, as well as by night, is always employed; and that often againſt, our wills, it intrudes where it is leaſt commanded or deſired. While awake, and in health, this buſy principle cannot much delude us: it may build caſtles in the air, and raiſe a thouſand phantoms before us; but we have every one of the ſenſes alive to bear teſtimony to its falſehood. Our eyes ſhew us that the proſpect is not preſent; our hearing and our touch, depoſe againſt its reality; and our taſte and ſmelling are equally vigilant in detecting the impoſtor. Reaſon, therefore, at once gives judgment upon the cauſe; and the vagrant intruder, Imagination, is impriſoned, or baniſhed from the mind. But in ſleep it is otherwiſe; having, as much as poſſible, put our ſenſes from their duty, having cloſed the eyes from ſeeing, and the ears, taſte, and ſmelling from their peculiar functions, and having diminiſhed even the touch itſelf, by all the arts of ſoftneſs, the imagination is then left to riot at large, and to lead the underſtanding without an oppoſer. Every incurſive idea then becomes a reality; and the mind, not having one power that can prove the illuſion, takes them for truths. As in madneſs, the ſenſes, from ſtruggling with the imagination, are at length forced to ſubmit, ſo, in ſleep, they ſeem for a while ſoothed into the like ſubmiſſion: the ſmalleſt violence exerted upon any one of them, however, rouzes all the reſt in their mutual defence; and the imagination, that had for a while told its thouſand falſehoods, is totally driven away, or only permitted to paſs under the cuſtody of ſuch as are every moment ready to detect its impoſition.

CHAP. VII.

OF SEEING*.

"HAVING mentioned the ſenſes as correcting the errors of the imagination, and as forcing it, in ſome meaſure, to bring us juſt information, it will naturally follow, that we ſhould examine the nature of thoſe ſenſes themſelves: we ſhall thus be enabled to ſee how far they alſo impoſe on us, and how far they contribute to correct each other. Let it be obſerved, however, that in this we are neither giving a treatiſe of optics, or phonics, but an hiſtory of our own perceptions: and to thoſe we chiefly confine ourſelves."

The eyes very ſoon begin to be formed in the human embryo, and in the chicken alſo. Of all the parts which the animal has double, the eyes are produced the ſooneſt, and appear the moſt prominent. It is true, indeed, that in viviparous animals, and particularly in man, they are not ſo large in proportion, at firſt, as in the oviparous kinds; nevertheleſs, they are more ſpeedily developed, when they begin to appear, than any other parts of the body. It is the ſame with the organ of hearing; the little bones that compoſe the internal parts of the ear are entirely formed before the other bones, though much larger, have acquired any part of their growth or ſolidity. Hence it appears, that thoſe parts of the body which are furniſhed with the greateſt quantity of the nerves are the firſt in forming. Thus the brain and the ſpinal-marrow, are the firſt ſeen begun in the embryo; and, in general, it may be ſaid, that wherever the nerves go, or ſend their branches in great numbers, there the parts are ſooneſt begun, and the moſt completely finiſhed.

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* This chapter is taken from Mr. Buffon. I believe the reader will readily excuſe any apology; and, perhaps, may wiſh that I had taken this liberty much more frequently. What I add is marked, as in a former inſtance, with inverted commas.

If we examine the eyes of a child ſome hours, or even ſome days after its birth, it will be eaſily diſcerned that it, as yet, makes no uſe of them. The humours of the organ not having acquired a ſufficient conſiſtence, the rays of light ſtrike but confuſedly upon the retina, or expanſion of the nerves at the back of the eye. It is not till about a month after they are born, that children fix them upon objects; for, before that time, they turn them indiſcriminately every where, without appearing to be affected by any. At ſix or ſeven weeks old, they plainly diſcover a choice in the objects of their attention; they fix their eyes upon the moſt brilliant colours, and ſeem peculiarly deſirous of turning them towards the light. Hitherto, however, they only ſeem to fortify the organ for ſeeing diſtinctly; but they have ſtill many illuſions to correct.

The firſt great error in viſion is, that the eye inverts every object; and it in reality appears to the child, until the touch has ſerved to undeceive it, turned upſide down. A ſecond error in viſion is, that every object appears double. The ſame object forms itſelf diſtinctly upon each eye; and is conſequently ſeen twice. This error, alſo, can only be corrected by the touch; and although, in reality, every object we ſee appears inverted and double, yet the judgment and habit have ſo often corrected the ſenſe, that we no longer ſubmit to its impoſition, but ſee every object in its juſt poſition, the very inſtant it appears. Were we, therefore, deprived of feeling, our eyes would not only miſrepreſent the ſituation, but alſo the number of all things round us.

To convince us that we ſee objects inverted, we have only to obſerve the manner in which images are repreſented, coming through a ſmall hole, in a darkened room. If ſuch a ſmall hole be made in a dark room, ſo that no light can come in, but through it, all the objects without will be painted on the wall behind, but in an inverted poſition, their heads downwards. For as all the rays which paſs from the different parts of the object without, cannot enter the hole in the ſame extent which they had in leaving the object, ſince, if ſo, they would require the aperture to be as large as the object; and, as each part, and every point of the object, ſends forth the image of itſelf on every ſide, and the rays, which form theſe images, paſs from all points of the object as from ſo many centres, ſo ſuch only can paſs through the ſmall aperture as come in oppoſite directions. Thus the little aperture becomes a centre for the entire object; through which the rays from the upper parts, as well as from the lower parts of it paſs in converging directions; and, conſequently, they muſt croſs each other in the central point, and thus paint the objects behind, upon the wall, in an inverted poſition.

It is, in like manner, eaſy to conceive, that we ſee all objects double, whatever our preſent ſenſations may ſeem to tell us to the contrary. For, to convince us of this, we have only to compare the ſituation of any one object on ſhutting one eye, and then compare the ſame ſituation by ſhutting the other. If, for inſtance, we hold up a finger, and ſhut the right eye, we ſhall find it hide a certain part of the room; if again reſhutting the other eye, we ſhall find that part of the room viſible, and the finger ſeeming to cover a part of the room that had been viſible before. If we open both eyes, however, the part covered will appear to lie between the two extremes. But, the truth is, we ſee the object, our finger had covered, one image of it to the right, and the other to the left; but, from habit, ſuppoſe that we ſee but one image placed between both; our ſenſe of feeling having corrected the errors of ſight. And thus, alſo, if inſtead of two eyes we had two hundred, we ſhould fancy the objects increaſed in proportion, until one ſenſe had corrected the errors of another.

"The having two eyes might thus be ſaid to be rather an inconvenience than a benefit; ſince one eye would anſwer the purpoſes of ſight as well, and be leſs liable to illuſion. But it is otherwiſe; two eyes greatly contribute, if not to diſtinct, at leaſt to extenſive viſion*. When an object is placed at a moderate diſtance, by the means of both eyes we ſee a larger ſhare of it than we poſſibly could with one; the right eye ſeeing a greater portion of its right ſide, and the left eye of its correſpondent ſide. Thus both eyes, in ſome meaſure, ſee round the object; and it is this that gives it, in nature, that bold relievo, or ſwelling, with which they appear; and which no painting, how exquiſite ſoever, can attain to. The painter muſt be contented with ſhading on a flat ſurface; but the eyes, in obſerving Nature, do not behold the ſhading only, but a part of the figure alſo, that lies behind theſe very ſhadings, which gives it that ſwelling, which painters ſo ardently deſire, but can never fully imitate.

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* Leonardo da Vinci.

"There is another defect, which either of the eyes, taken ſingly, would have, but which is corrected, by having the organ double. In either eye there is a point, which has no viſion whatſoever; ſo that if one of them only is employed in ſeeing, there is a part of the object to which it is always totally blind. This is that part of the optic nerve where its vein and artery run; which being inſenſible, that point of the object that is painted there muſt continue unſeen. To be convinced of this we have only to try a very eaſy experiment. If we take three black patches, and ſtick them upon a white wall, about a foot diſtant from each other, each about as high as the eye that is to obſerve them; then retiring ſix or ſeven feet back, and ſhutting one eye, by trying for ſome time, we ſhall find, that while we diſtinctly behold the black ſpots that are to the right and left, that which is in the middle remains totally unſeen. Or, in other words, when we bring that part of the eye, where the optic artery runs, to fall upon the object, it will then become inviſible. This defect, however, in either eye, is always corrected by both, ſince the part of the object that is unſeen by one, will be very diſtinctly perceived by the other."

Beſide the former defects, we can have no idea of diſtances from the ſight, without the help of touch. Naturally every object we ſee appears to be within our eyes; and a child, who has as yet made but little uſe of the ſenſe of feeling, muſt ſuppoſe that every thing is ſees make a part of itſelf. Such objects are only ſeen more or leſs bulky as they approach, or recede from its eyes; ſo that a fly that is near will appear larger than ox at a diſtance. It is experience alone that can rectify this miſtake; and a long acquaintance with the real ſize of every object, quickly aſſures us of the diſtance at which it is ſeen. The laſt man in a file of ſoldiers appears in reality much leſs, perhaps ten times more diminutive, than the man next to us; however, we do not perceive this difference, but continue to think him of equal ſtature; for the numbers we have ſeen thus leſſened by diſtance, and have found, by repeated experience, to be of the natural ſize, when we come cloſer, inſtantly corrects the ſenſe, and every object is perceived with nearly its natural proportion. But it is otherwiſe, if we obſerve objects in ſuch ſituations as we have not had ſufficient experience to correct the errors of the eye; if, for inſtance, we look at men from the top of an high ſteeple, they, in that caſe, appear very much diminiſhed, as we have not had an habit of correcting the ſenſe in that poſition.

Although a ſmall degree of reflection will ſerve to convince us of the truth of theſe poſitions, it may not be amiſs to ſtrengthen them by an authority which cannot be diſputed. Mr. Cheſelden having couched a boy of thirteen of a cataract, who had hitherto been blind, and thus at once having reſtored him to ſight, curiouſly marked the progreſs of his mind, upon that occaſion. This youth, though he had been till then incapable of ſeeing, yet was not totally blind, but could tell day from night, as perſons in his ſituation always may. He could alſo, with a ſtrong light, diſtinguiſh black from white, and either from the vivid colour of ſcarlet: however, he ſaw nothing of the form of bodies; and, without a bright light, not even colours themſelves. He was, at firſt, couched only in one of his eyes; and, when he ſaw for the firſt time, he was ſo far from judging of diſtances, that he ſuppoſed his eyes touched every object that he ſaw, in the ſame manner as his hands might be ſaid to feel them. The objects that were moſt agreeable to him were ſuch as were of plain ſurfaces and regular figures; though he could as yet make no judgment whatever of their different forms, nor give a reaſon why one pleaſed him more than another. Although he could form ſome idea of colours during his ſtate of blindneſs, yet that was not ſufficient to direct him at preſent; and he could ſcarcely be perſuaded that the colours he now ſaw were the ſame with thoſe he had formerly conceived ſuch erroneous ideas of. He delighted moſt in green;

but black objects, as if giving him an idea of his former blindneſs, he regarded with horror. He had, as was ſaid, no idea of forms; and was unable to diſtinguiſh one object from another, though never ſo different. When thoſe things were ſhewn him, which he had been formerly familiarized to, by his feelings, he beheld them with earneſtneſs, in order to remember them a ſecond time; but, as he had too many to recollect at once, he forgot the greateſt number; and for one he could tell, after ſeeing, there was a thouſand he was totally unacquainted with. He was very much ſurpriſed to find, that thoſe things, and perſons he loved beſt, were not the moſt beautiful to be ſeen; and even teſtified diſpleaſure in not finding his parents ſo handſome as he conceived them to be. It was near two months before he could find that a picture reſembled a ſolid body. Till then he only conſidered it as a flat ſurface, variouſly ſhadowed; but, when he began to perceive that theſe kind of ſhadings actually repreſented human beings, he then began to examine, by his touch, whether they had not the uſual qualities of ſuch bodies, and was greatly ſurpriſed to find, what he expected a very unequal ſurface, to be ſmooth and even. He was then ſhewn a miniature picture of his father, which was contained in his mother's watch-caſe, and he readily perceived the reſemblance; but aſked, with great aſtoniſhment, how ſo large a face could be contained in ſo ſmall a compaſs? It ſeemed as ſtrange to him as if a buſhel was contained in a pint veſſel. At firſt, he could bear but a very ſmall quantity of light, and he ſaw every object much greater than the life; but, in proportion as he ſaw objects that were really large, he ſeemed to think the former were diminiſhed; and although he knew the chamber where he was contained in the houſe, yet until he ſaw the latter, he could not be brought to conceive how an houſe could be larger than a chamber. Before the operation he had no great expectations from the pleaſure he ſhould receive from a new ſenſe; he was only excited by the hopes of being able to read and write; he ſaid, for inſtance, that he could have no greater pleaſure in walking, in the garden, with his ſight, than he had without it, for he walked there at his eaſe, and was acquainted with all the walks. He remarked alſo, with great juſtice, that his former blindneſs gave him one advantage over the reſt of mankind, which was that of being able to walk in the night, with confidence and ſecurity. But, when he began to make uſe of his new ſenſe, he ſeemed tranſported beyond meaſure. He ſaid that every new object was a new ſource of delight, and that his pleaſure was ſo great as to be paſt expreſſion. About a year after, he was brought to Epſom, where there is a very fine proſpect, with which he ſeemed greatly charmed; and he called the landſcape before him a new method of ſeeing. He was couched in the other eye, a year after the former, and the operation ſucceeded equally well: when he ſaw with both eyes, he ſaid that objects appeared to him twice as large as when he ſaw with but one; however, he did not ſee them doubled, or at leaſt he ſhewed no marks as if he ſaw them ſo. Mr. Cheſelden mentions inſtances of many more that were reſtored to ſight in this manner; they all ſeemed to concur in their perceptions with this youth; and they all ſeemed particularly embarraſſed in learning how to direct their eyes to the objects they wiſhed to obſerve.

In this manner it is that our feeling corrects the ſenſe of ſeeing, and that objects which appear of very different ſizes, at different diſtances, are all reduced, by experience, to their natural ſtandard. "But not the feeling only, but alſo the colour, and brightneſs of the object, contributes, in ſome meaſure, to aſſiſt us in forming an idea of the diſtance at which it appears*. Thoſe which we ſee moſt ſtrongly marked with light and ſhade, we readily know to be nearer than thoſe on which the colours are more faintly ſpread, and that, in ſome meaſure, take a part of their hue from the air between us and them. Bright objects alſo, are ſeen at a greater diſtance than ſuch as are obſcure, and, moſt probably, for this reaſon, that being leſs ſimilar in colour, to the air which interpoſes, their impreſſions are leſs effaced by it, and they continue more diſtinctly viſible. Thus a black and diſtant object is not ſeen ſo far off as a bright and glittering one, and a fire by night is ſeen much farther off than by day."

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* Mr. Buffon gives a different theory, for which I muſt refer the raader to the original. That I have given, I take to be eaſy, and ſatisfactory enough.

The power of ſeeing objects at a diſtance is very rarely equal in both eyes. When this inequality is in any great degree, the perſon ſo circumſtanced then makes uſe only of one eye, ſhutting that which ſees the leaſt, and employing the other with all its power. And hence proceeds that awkward look which is known by the name of *ſtrabiſm.*

There are many reaſons to induce us to think that ſuch as are near ſighted ſee objects larger than other perſons; and yet the contrary is moſt certainly true, for they ſee them leſs. Mr. Buffon informs us that he himſelf is ſhort-ſighted, and that his left eye is ſtronger than his right. He has very frequently experienced, upon looking at any object, ſuch as the letters of a book, that they appear leſs to the weakeſt eye; and that when he places the book, ſo as that the letters appear double, the images of the left eye, which is ſtrongeſt, are greater than thoſe of the right, which is the moſt feeble. He has examined ſeveral others, who were in ſimilar circumſtances, and has always found that the beſt eye ſaw every object the largeſt. This he aſcribes to habit; for near-ſighted people being accuſtomed to come cloſe to the object, and view but a ſmall part of it at a time, the habit enſues, when the whole of an object is ſeen, and it appears leſs to them than to others.

Infants having their eyes leſs than thoſe of adults, muſt ſee objects alſo ſmaller in proportion. For the image formed on the back of the eye will be large, as the eye is capacious; and infants, having it not ſo great, cannot have ſo large a picture of the object. This may be a reaſon alſo why they are unable to ſee ſo diſtinctly, or at ſuch diſtances as perſons arrived at maturity.

Old men, on the contrary, ſee bodies cloſe to them very indiſtinctly, but bodies at a great diſtance from them with more preciſion; and this may happen from an alteration in the coats, or, perhaps, humours of the eye; and not, as is ſuppoſed, from their diminution. The cornea, for inſtance, may become too rigid to adapt itſelf, and take a proper convexity for ſeeing minute objects; and its very flatneſs will be ſufficient to fit it for diſtant viſion.

When we caſt our eyes upon an object extremely brilliant, or when we fix and detain them too long upon the ſame object, the organ is hurt and fatigued, its viſion becomes indiſtinct, and the image of the body, which has thus too violently, or too perſeveringly employed us, is painted upon every thing we look at, and mixes with every object that occurs. " And this is an abvious conſequence of the eye taking in too much light, either immediately, or by reflection. Every body expoſed to the light, for a time, drinks in a quantity of its rays, which, being brought into darkneſs, it cannot inſtantly diſcharge. Thus the hand, if it be expoſed to broad day-light, for ſome time, and then immediately ſnatched into a dark room, will appear ſtill luminous; and it will be ſome time before it is totally darkened. It is thus with the eye; which, either by an inſtant gaze at the ſun, or a ſteady continuance upon ſome leſs brilliant object, has taken in too much light; its humours are, for a while, unfit for viſion, until that be diſcharged, and room made for rays of a milder nature." How dangerous the looking upon bright and luminous objects is to the ſight, may be eaſily ſeen, from ſuch as live in countries, covered for moſt part of the year with ſnow, who become generally blind before their time. Travellers who croſs theſe countries, are obliged to wear a crape before their eyes, to ſave their eyes, which would otherwiſe be rendered totally unſerviceable; and it is equally dangerous in the ſandy plains of Africa. The reflection of the light is there ſo ſtrong, that it is impoſſible to ſuſtain the effect, without incurring the danger of loſing one's ſight entirely. Such perſons, therefore, as read, or write for any continuance, ſhould chooſe a moderate light, in order to ſave their eyes; and, although it may ſeem inſufficient at firſt, the eye will accuſtom itſelf to the ſhade, by degrees, and be leſs hurt by the want of light than the exceſs.

" It is, indeed, ſurpriſing how far the eye can accommodate itſelf to darkneſs, and make the beſt of a gloomy ſituation. When firſt taken from the light, and brought into a dark room, all things diſappear; or, if any thing is ſeen, it is only the remaining radiations that ſtill continue in the eye. But, after a very little time, when theſe are ſpent, the eye takes the advantage of the ſmalleſt ray that happens to enter; and this alone would, in time, ſerve for many of the purpoſes of life. There was a gentleman of great courage and underſtanding, who was a major under King Charles I. This unfortunate man, ſharing in his maſter's misfortunes, and being forced abroad, ventured at Madrid to do his king a ſignal ſervice; but, unluckily, failed in the attempt. In conſequence of this, he was inſtantly ordered to a dark and diſmal dungeon, into which the light never entered, and into which there was no opening but by a hole at the top; down which the keeper put his proviſions, and preſently cloſed it again on the other ſide. In this manner the unfortunate loyaliſt continued for ſome weeks, diſtreſſed and diſconſolate; but at laſt he began to think he ſaw ſome little glimmering of light. This internal dawn ſeemed to increaſe from time to time, ſo that he could not only diſcover the parts of his bed, and ſuch other large objects, but, at length, he even began to perceive the mice that frequented his cell; and ſaw them as they ran about the floor, eating the crumbs of bread that happened to fall. After ſome months confinement he was at laſt ſet free; but ſuch was the effect of the darkneſs upon him, that he could not for ſome days venture to leave his dungeon, but was obliged to accuſtom himſelf by degrees to the light of the day.

CHAP. VIII.

OF HEARING*.

As the ſenſe of hearing, as well as of ſight, gives us notice of remote objects, ſo, like that, it is ſubject to ſimilar errors, being capable of impoſing on us upon all occaſions, where we cannot rectify it by the ſenſe of feeling. We can have from it no diſtinct intelligence of the diſtance from whence a ſounding body is heard; a great noiſe far off, and a ſmall one very near, produce the ſame ſenſation; and, unleſs we receive information from ſome other ſenſe, we can never diſtinctly tell whether the ſound be a great or a ſmall one. It is not till we have learned, by experience, that the particular ſound which is heard, is of a peculiar kind; then we can judge of the diſtance from whence we hear it. When we know the tone of the bell, we can then judge how far it is from us.

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* This chapter is taken from Mr. Buffon, except where marked by inverted commas.

Every body that ſtrikes againſt another produces a ſound, which is ſimple, and but one in bodies which are not elaſtic, but which is often repeated in ſuch as are. If we ſtrike a bell, or a ſtretched ſtring, for inſtance, which are both elaſtic, a ſingle blow produces a ſound, which is repeated by the undulations of the ſonorous body, and which is multiplied as often as it happens to undulate or vibrate. Theſe undulations each ſtrike their own peculiar blow; but they ſucceed ſo faſt, one behind the other, that the ear ſuppoſes them one continued ſound; whereas, in reality, they make many. A perſon who ſhould, for the firſt time, hear the toll of the bell, would, very probably, be able to diſtinguiſh theſe breaks of ſound; and, in fact, we can readily ourſelves perceive an intenſion and remiſſion in the ſound.

In this manner, ſounding bodies are of two kinds; thoſe unelaſtic ones, which being ſtruck, return but a ſingle ſound; and thoſe more elaſtic, returning a ſucceſſion of ſound; which uniting together form a tone. This tone may be conſidered as a great number of ſounds, all produced one after the other, by the ſame body, as we find in a bell, or the ſtring of an harpſichord, which continues to ſound for ſome time after it is ſtruck. A continuing tone may be alſo produced from a nonelaſtic body, by repeating the blow quick and often, as when we beat a drum, or when we draw a bow along the ſtring of a fiddle.

Conſidering the ſubject in this light, if we ſhould multiply the number of blows, or repeat them at quicker intervals upon the ſounding body, as upon the drum, for inſtance, it is evident that this will have no effect in altering the tone; it will only make it either more even or more diſtinct. But it is otherwiſe, if we increaſe the force of the blow; if we ſtrike the body with double weight, this will produce a tone twice as loud as the former. If, for inſtance, I ſtrike a table with a ſwitch, this will be very different from the ſound produced by ſtriking it with a cudgel. Hence, therefore, we may infer, that all bodies give a louder and graver tone, not in proportion to the number of times they are ſtruck, but in proportion to the force that ſtrikes them. And, if this be ſo, thoſe philoſophers who make the tone of a ſonorous body, of a bell, or the ſtring of a harpſichord, for inſtance, to depend upon the number only of its vibrations, and not the force, have miſtaken what is only an effect for a cauſe. A bell, or an elaſtic ſtring, can only be conſidered as a drum beaten; and the frequency of the blows can make no alteration whatever in the tone. The largeſt bells, and the longeſt and thickeſt ſtrings, have the moſt forceful vibrations; and, therefore, their tones are the moſt loud and the moſt grave.

To know the manner in which ſounds thus produced become pleaſing, it muſt be obſerved, no one continuing tone, how loud or ſwelling ſoever, can give us ſatisfaction; we muſt have a ſucceſſion of them, and thoſe in the moſt pleaſing proportion. The nature of this proportion may be thus conceived. If we ſtrike a body incapable of vibration with a double force, or, what amounts to the ſame thing, with a double maſs of matter, it will produce a ſound that will be doubly grave. Muſic has been ſaid, by the ancients, to have been firſt invented from the blows of different hammers on an anvil. Suppoſe then we ſtrike an anvil with a hammer of one pound weight, and again with a hammer of two pounds, it is plain that the two pound hammer will produce a ſound twice as grave as the former. But if we ſtrike with a two pound hammer, and then with a three pound, it is evident that the latter will produce a ſound one third more grave than the former. If we ſtrike the anvil with a three pound hammer, and then with a four pound, it will likewiſe follow that the latter will be a quarter part more grave than the former. Now, in the comparing between all thoſe ſounds, it is obvious that the difference between one and two is more eaſily perceived, than between two and three, three and four, or any numbers ſucceeding in the ſame proportion. The ſucceſſion of ſounds will be, therefore, pleaſing in proportion to the eaſe with which they may be diſtinguiſhed.—That ſound which is double the former, or, in other words, the octave to the preceding tone, will, of all others, be the moſt pleaſing harmony. The next to that, which is as two to three, or, in other words, the third, will be moſt agreeable. And thus, univerſally, thoſe ſounds whoſe difference may be moſt eaſily compared, are the moſt agreeable.

"Muſicians, therefore, have contented themſelves with ſeven different proportions of ſound, which are called *notes*, and which ſufficiently anſwer all the purpoſes of pleaſure. Not but that they might adopt a greater diverſity of proportions; and ſome have actually done ſo; but, in theſe, the differences of the proportion are ſo imperceptible, that the ear is rather fatigued than pleaſed in making the diſtinction. In order, however, to give variety, they have admitted half tones; but in all the countries where muſic is yet in its infancy, they have rejected ſuch; and they can find muſic in none but the obvious ones. The Chineſe, for inſtance, have neither flats nor ſharps in their muſic; but the intervals between their other notes, are in the ſame proportion with ours.

"Many more barbarous nations have their peculiar inſtruments of muſic; and what is remarkable, the proportion between their notes is in all the ſame as in ours. This is not the place for entering into the nature of theſe ſounds, their effects upon the air, or their conſonances with each other. We are not now giving a hiſtory of ſound, but of human perception.

"All countries are pleaſed with muſic; and if they have not ſkill enough to produce harmony, at leaſt they ſeem willing to ſubſtitute noiſe. Without all queſtion, noiſe alone is ſufficient to operate powerfully on the ſpirits; and, if the mind be already prediſpoſed to joy, I have ſeldom found noiſe fail of increaſing it into rapture. The mind feels a kind of diſtracted pleaſure in ſuch powerful ſounds, braces up every nerve, and riots in the exceſs. But, as in the eye, an immediate gaze upon the ſun will diſturb the organ, ſo in the ear, a loud, unexpected noiſe diſorders the whole frame, and ſometimes diſturbs the ſenſe ever after. The mind muſt have time to prepare for the expected ſhock, and to give its organs the proper tenſion for its arrival.

"Muſical ſounds, however, ſeem of a different kind. Theſe are generally moſt pleaſing which are moſt unexpected. It is not from bracing up the nerves, but from the grateful ſucceſſion of the ſounds, that theſe become ſo charming. There are few, how indifferent ſoever, but have at times felt their pleaſing impreſſion; and, perhaps, even thoſe who have ſtood out againſt the powerful perſuaſion of ſounds, only wanted the proper tune, or the proper inſtrument to allure them.

"The ancients give us a thouſand ſtrange inſtances of the effects of muſic, upon men and animals. The ſtory of Arion's harp, that gathered the dolphins to the ſhip-ſide, is well known; and what is remarkable, Schotteus aſſures us*, that he ſaw a ſimilar inſtance of fiſhes being allured by muſic. They tell us of diſeaſes that have been cured, unchaſtity corrected, ſeditions quelled, paſſions removed, and ſometimes excited even to madneſs. Dr. Wallis has endeavoured to account for theſe ſurpriſing effects, by aſcribing them to the novelty of the art. For my own part, I can ſcarce heſitate to impute them to the exaggeration of their writers. They are as hyperbolical in the effects of their oratory; and yet, we well know, there is nothing in the orations which they have left us, capable of exciting madneſs, or of raiſing the mind to that ungovernable degree of fury which they deſcribe. As they have exaggerated, therefore, in one inſtance, we may naturally ſuppoſe, that they have done the ſame in the other: and, indeed, from the few remains we have of their muſic, collected by Meibomius, one might be apt to ſuppoſe, there was nothing very powerful in what is loſt. Nor does any one of the ancient inſtruments, ſuch as we ſee them repreſented in ſtatues, appear comparable to our fiddle.

"However this be, we have many odd accounts, not only among them, but the moderns, of the power of muſic; and it muſt not be denied, but that, on ſome particular occaſions, muſical ſounds may have a very powerful effect. I have ſeen all the horſes and cows in a field, where there were above a hundred, gather round a perſon that was blowing the French horn, and ſeeming to teſtify an awkward kind of ſatisfaction. Dogs are well known to be very ſenſible of different tones in muſic; and I have ſometimes heard them ſuſtain a very ridiculous part in a concert, where their aſſiſtance was neither expected nor deſired.

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* Quod oculis meis ſpectavi, Schotti Magic. univerſalis, pars ii. l. 1. p. 26.

" We are told of Henry IV. of Denmark*, that being one day deſirous of trying in perſon whether a muſician, who boaſted that he could excite men to madneſs, was not an impoſtor, he ſubmitted to the operation of his ſkill: but the conſequence was much more terrible than he expected; for, becoming actually mad, he killed four of his attendants in the midſt of his tranſports. A contrary effect of muſic we have†, in the cure of a madman of Alais, in France, by muſic. This man, who was a dancing-maſter, after a fever of five days, grew furious, and ſo ungovernable that his hands were obliged to be tied to his ſides: what at firſt was rage, in a ſhort time was converted into ſilent melancholy, which no arts could exhilerate, nor no medicines remove. In this ſullen and dejected ſtate, an old acquaintance accidentally came to inquire after his health; he found him ſitting up in bed, tied, and totally regardleſs of every external object round him. Happening, however, to take up a fiddle that lay in the room, and touching a favourite air, the poor madman inſtantly ſeemed to brighten up at the ſound; from a recumbent poſture, he began to ſit up; and as the muſician continued playing, the patient ſeemed deſirous of dancing to the ſound: but he was tied, and incapable of leaving his bed, ſo that he could only humour the tune with his head, and that part of his arms which were at liberty. Thus the other continued playing, and the dancing-maſter practiſed his own art, as far as he was able, for about a quarter of an hour, when ſuddenly falling into a deep ſleep, in which his diſorder came to a criſis, he awaked perfectly recovered.

" A thouſand other inſtances might be added, equally true: let it ſuffice to add one more, which is not true; I mean that of the tarantula. Every perſon who has been in Italy now well knows, that the bite of this animal, and its being cured by muſic, is all a deception. When ſtrangers come into that part of the country, the country people are ready enough to take money for dancing to the tarantula. A friend of mine had a ſervant who ſuffered himſelf to be bit; the wound, which was little larger than the puncture of a pin, was uneaſy for a few hours, and then became well without any farther aſſiſtance. Some of the country people, however, ſtill make a tolerable livelihood of the credulity of ſtrangers, as the muſician finds his account in it no leſs than the dancer."

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* Olaii Magni, l. 15. hiſt. c. 28.

† Hiſt. de l' Acad. 1708, p. 22.

Sounds like light, are not only extenſively diffuſed, but are frequently reflected. The laws of this reflection, it is true, are not as well underſtood, as thoſe of light; all we know is, that ſound is principally reflected by hard bodies; and their being hollow, alſo, ſometimes increaſes the reverberation. "No art, however, can make an echo; and ſome who have beſtowed great labour and expence upon ſuch a project, have only erected ſhapeleſs buildings, whoſe ſilence was a mortifying lecture upon their preſumption."

The internal cavity of the ear ſeems to be fitted up for the purpoſes of echoing ſound with the greateſt preciſion. This part is faſhioned out in the temporal bone, like a cavern cut into a rock. "In this the ſound is repeated and articulated; and, as ſome anatomiſts tell us (for we have as yet but very little knowledge on this ſubject), is beaten againſt the tympanum, or drum of the ear, which moves four little bones joined thereto; and theſe move and agitate the internal air which lies on the other ſide; and, laſtly, this air ſtrikes and affects the auditory nerves, which carry the ſound to the brain."

One of the moſt common diſorders in old age is deafneſs; which probably proceeds from the rigidity of the nerves in the labyrinth of the ear. This diſorder, alſo, ſometimes proceeds from a ſtoppage of the wax, which art may eaſily remedy. In order to know whether the defect be an internal or an external one, let the deaf perſon put a repeating-watch into his mouth, and if he hears it ſtrike, he may be aſſured that his diſorder proceeds from an external cauſe, and is, in ſome meaſure, curable: "for there is a paſſage from the ears into the mouth, by what anatomiſts call the *euſtachian tube*; and, by this paſſage, people often hear ſounds, when they are utterly without hearing through the larger channel: and this alſo is the reaſon that we often ſee perſons who liſten with great attention, hearken with their mouths open, in order to catch all the ſound at every aperture."

It often happens, that perſons hear differently with one ear from the other; and it is generally found that theſe have what is called, by muſicians, *a bad ear*. Mr. Buffon, who has made many trials upon perſons of this kind, always found that their defect in judging properly of ſounds proceeded from the inequality of their ears; and receiving by both, at the ſame time, unequal ſenſations, they form an unjuſt idea. In this manner, as thoſe people hear falſe, they alſo, without knowing it, ſing falſe. Thoſe perſons alſo frequently deceive themſelves with regard to the ſide from whence the ſound comes, generally ſuppoſing the noiſe to come on the part of the beſt ear.

Such as are hard of hearing, find the ſame advantage in the trumpet made for this purpoſe, that ſhort-ſighted perſons do from glaſſes. Theſe trumpets might be eaſily improved, ſo as to increaſe ſounds, in the ſame manner that the teleſcope does objects: however, they could be uſed to advantage only in a place of ſolitude and ſtillneſs, as the neighbouring ſounds would mix with the more diſtant, and the whole would produce in the ear nothing but tumult and confuſion.

Hearing is a much more neceſſary ſenſe to man than to animals. With theſe it is only a warning againſt danger, or an encouragement to mutual aſſiſtance. In man, it is the ſource of moſt of his pleaſures: and without which the reſt of his ſenſes would be of little benefit. A man born deaf, muſt neceſſarily be dumb; and his whole ſphere of knowledge muſt be bounded only by ſenſual objects. We have an inſtance of a young man, who, being born deaf, was reſtored at the age of twenty-four, to perfect hearing: the account is given in the Memoirs of the Academy of Sciences, 1703, page 18.

A young man, of the town of Chartres, between the age of twenty-three and twenty-four, the ſon of a tradeſman, and deaf and dumb from his birth, began to ſpeak all of a ſudden to the great aſtoniſhment of the whole town. He gave them to underſtand that, about three or four months before, he had heard the ſound of the bells for the firſt time, and was greatly ſurpriſed at this new and unknown ſenſation. After ſome time, a kind of water iſſued from his left ear, and he then heard perfectly well with both. During theſe three months, he was ſeduloufly employed in liſtening without ſaying a word and accuſtoming himſelf to ſpeak ſoftly (ſo as not to be heard) the words pronounced by others. He laboured hard alſo in perfecting himſelf in the pronunciation, and in the ideas attached to every ſound. At length, having ſuppoſed himſelf qualified to break ſilence, he declared, that he could now ſpeak, although as yet but imperfectly. Soon after, ſome able divines queſtioned him concerning his ideas of his paſt ſtate; and principally with reſpect to God, his ſoul, the morality or turpitude of actions. The young, however, had not driven his ſolitary ſpeculations into that channel. He had gone to maſs indeed with his parents, had learned to ſign himſelf with the croſs, to kneel down and aſſume all the grimaces of a man that was praying; but he did all this without any manner of knowledge of the intention or the cauſe; he ſaw others do the like, and that was enough for him; he knew nothing even of death, and it never entered into his head; he led a life of pure animal inſtinct; entirely taken up with ſenſible objects, and ſuch as were preſent, he did not ſeem even to make as many reflections upon theſe, as might reaſonably be expected from his improving ſituation: and yet, the young man was not in want of underſtanding; but the underſtanding of a man deprived of all commerce with others, is ſo very confined, that the mind is in ſome meaſure totally under the control of its immediate ſenſations.

Notwithſtanding, it is very poſſible to communicate ideas to deaf men, which they previouſly wanted, and even give them very preciſe notions of ſome abſtract ſubjects, by means of ſigns, and of letters. A perſon born deaf, may, by time, and ſufficient pains, be taught to write and read, to ſpeak, and, by the motions of the lips, to underſtand what is ſaid to him: however, it is probable that, as moſt of the motions of ſpeech are made within the mouth by the tongue, the knowledge from the motion of the lips, is but very confined: " neverthleſs, I have converſed with a gentleman thus taught, and in all the commonly occuring queſtions, and the uſual ſalutations, he was ready enough, merely by attending to the motion of the lips alone. When I ventured to ſpeak for a ſhort continuance, he was totally at loſs, although he underſtood the ſubject, when written, extremely well." Perſons taught in this manner, were at firſt conſidered as prodigies; but there have been ſo many inſtances of ſucceſs of late, and ſo many are ſkilful in the art of inſtructing in this way, that, though ſtill a matter of ſome curioſity, it ceaſes to be an object of wonder.

CHAP. IX.

OF SMELLING, FEELING, AND TASTING.

AN animal may be ſaid to fill up that ſphere which he can reach by his ſenſes; and is actually large in proportion to the ſphere to which its organ extends. By ſight, man's enjoyments are diffuſed into a wide circle; that of hearing, though leſs widely diffuſed, nevertheleſs extends his powers; the ſenſe of ſmelling is more contracted ſtill; and the taſte and touch are the moſt confined of all. Thus man enjoys very diſtant objects, but with one ſenſe only; more nearly he brings two ſenſes at once to bear upon them; his ſenſe of ſmelling aſſiſts the other two, at its own diſtance; and of ſuch objects, as a man, he may be ſaid to be in perfect poſſeſſion.

Each ſenſe, however, the more it acts at a diſtance, the more capable it is of making combinations; and is, conſequently, the more improveable. Refined imaginations, and men of ſtrong minds, take more pleaſure, therefore, in improving the delights of the diſtant ſenſes, than in enjoying ſuch as are ſcarce capable of improvement.

By combining the objects of the extenſive ſenſes, all the arts of poetry, painting, and harmony have been diſcovered; but the cloſer ſenſes, if I may ſo call them, ſuch as ſmelling, taſting, and touching, are, in ſome meaſure, as ſimple as they are limited, and admit of little variety. The man of imagination makes a great and an artificial happineſs, by the pleaſure of altering and combining; the ſenſualiſt juſt ſtops where he began, and cultivates only thoſe pleaſures which he cannot improve. The ſenſualiſt is contented with thoſe enjoyments that are already made to his hand; but the man of pleaſure is beſt pleaſed with growing happineſs.

Of all the ſenſes, perhaps, there is not one in which man is more inferior to other animals than in that of ſmelling. With man, it is a ſenſe that acts in a narrow ſphere, and diſguſts almoſt as frequently as it gives him pleaſure. With many other animals it is diffuſed to a very great extent; and never ſeems to offend them. Dogs not only trace the ſteps of other animals, but alſo diſcover them by the ſcent at a very great diſtance; and while they are thus exquiſitely ſenſible of all ſmells, they ſeem no way diſguſted by any.

But, although this ſenſe is, in general, ſo very inferior in man, it is much ſtronger in thoſe nations that abſtain from animal food, than among Europeans. The Bramins of India have a power of ſmelling, as I am informed, equal to what it is in moſt other creatures. They can ſmell the water which they drink, that to us ſeems quite inodorous; and have a word, in their language, which denotes a country of fine water. We are told, alſo, that the Negroes of the Antilles, by the ſmell alone, can diſtinguiſh between the footſteps of a Frenchman and a Negro. It is poſſible, therefore, that we may dull this organ by our luxurious way of living; and ſacrifice to the pleaſures of taſte, thoſe which might be received from perfume.

However, it is a ſenſe that we can, in ſome meaſure, diſpenſe with; and I have known many that wanted it entirely, with but very little inconvenience from its loſs. In a ſtate of nature it is ſaid to be uſeful in guiding us to proper nouriſhment, and deterring us from that which is unwholeſome; but, in our preſent ſituation, ſuch information is but little wanted; and, indeed, but little attended to. In fact, the ſenſe of ſmelling gives us very often falſe intelligence. Many things that have a diſagreeable odour are, nevertheleſs, wholeſome, and pleaſant to the taſte; and ſuch as make eating an art, ſeldom think a meal fit to pleaſe the appetite till it begins to offend the noſe. On the other hand, there are many things that ſmell moſt gratefully, and yet are noxious, or fatal to the conſtitution. Some phyſicians think that perfumes in general are unwholeſome; that they relax the nerves, produce headachs, and even retard digeſtion. The machinel apple, which is known to be deadly poiſon, is poſſeſſed of the moſt grateful odour. Some of thoſe mineral vapours that are often found fatal in the ſtomach, ſmell like the ſweeteſt flowers, and continue thus to flatter till they deſtroy. This ſenſe, therefore, as it ſhould ſeem, was never meant to direct us in the choice of food, but appears rather as an attendant than a neceſſary pleaſure.

Indeed, if we examine the natives of different countries, or even different natives of the ſame, we ſhall find no pleaſure in which they differ ſo widely as that of ſmelling. Some perſons are pleaſed with the ſmell of a roſe; while I have known others that could not abide to have it approach them. The ſavage nations are highly delighted with the ſmell of aſſafœtida, which is to us the moſt nauſeous ſtink in nature. It would in a manner ſeem that our delight in perfumes was made by habit; and that a very little induſtry could bring us totally to invert the perception of odours.

Thus much is certain, that many bodies which at one diſtance are an agreeable perfume, when nearer are a moſt ungrateful odour. Muſk and ambergris, in ſmall quantities, are conſidered by moſt perſons as highly fragrant; and yet, when in larger maſſes, their ſcent is inſufferable. From a mixture of two bodies, each whereof is, of itſelf, void of all ſmell, a very powerful ſmell may be drawn. Thus, by grinding quick-lime with ſal-ammoniac, may be produced a very fœtid mixture. On the contrary, from a mixture of two bodies, that are ſeparately diſagreeable, a very pleaſant aromatic odour may be gained. A mixture of aqua-fortis with ſpirit of wine produces this effect. But not only the alterations of bodies by each other, but the ſmalleſt change in us makes a very great alteration in this ſenſe, and frequently deprives us of it totally. A ſlight cold often hinders us from ſmelling; and as often changes the nature of odours. Some perſons, from diſorder, retain an incurable averſion to thoſe ſmells which moſt pleaſed them before; and many have been known to have an antipathy to ſome animals, whoſe preſence they inſtantly perceive by the ſmell. From all this, therefore, the ſenſe of ſmelling appears to be an uncertain monitor, eaſily diſordered, and not much miſſed when totally wanting.

The ſenſe moſt nearly allied to ſmelling is that of taſting. This, ſome have been willing to conſider merely as a nicer kind of touch, and have undertaken to account in a very mechanical manner, for the difference of ſavours. "Such bodies," ſaid they, "as are pointed, happening to be applied to the papillæ of the tongue, excite a very powerful ſenſation, and give us the idea of ſaltneſs. Such, on the contrary, as are of a rounder figure, ſlide ſmoothly along the papillæ, and are perceived to be ſweet." In this manner they have, with minute labour, gone through the variety of imagined forms in bodies, and have given them as imaginary effects. All we can preciſely determine upon the nature of taſtes is, that the bodies to be taſted muſt be either ſomewhat moiſtened, or, in ſome meaſure, diſſolved by the ſaliva before they can produce a proper ſenſation: when both the tongue itſelf, and the body to be taſted are extremely dry, no taſte whatever enſues. The ſenſation is then changed; and the tongue, inſtead of taſting, can only be ſaid, like any other part of the body, to feel the object.

It is for this reaſon that children have a ſtronger reliſh of taſtes than thoſe who are more advanced in life. This organ with them, from the greater moiſture of their bodies, is kept in greater perfection; and is, conſequently, better adapted to perform its functions. Every perſon remembers how great a pleaſure he found in ſweets, while a child; but his taſte growing more obtuſe, with age, he is obliged to uſe artificial means to excite it. It is then that he is found to call in the aſſiſtance of poignant ſauces, and ſtrong reliſhes of ſalts and aromatics; all which the delicacy of his tender organ, in childhood, were unable to endure. His taſte grows callous to the natural reliſhes; and is artificially formed to others more unnatural; ſo that the higheſt epicure may be ſaid to have the moſt depraved taſte; as it is owing to the bluntneſs of his organs that he is obliged to have recourſe to ſuch a variety of expedients, to gratify his appetite.

As ſmells are often rendered agreeable by habit, ſo alſo taſtes may be. Tobacco and coffee, ſo pleaſing to many, are yet, at firſt, very diſagreeable to all. It is not without perſeverance that we begin to have a reliſh for them; we force Nature ſo long, that what was conſtraint in the beginning, at laſt becomes inclination.

The groſſeſt, and yet the moſt uſeful of all the ſenſes, is that of feeling. We are often ſeen to ſurvive under the loſs of the reſt; but of this we can never be totally deprived, but with life. Although this ſenſe is diffuſed over all parts of the body, yet it moſt frequently happens that thoſe parts which are moſt exerciſed in touching, acquire the greateſt degree of accuracy. Thus the fingers, by long habit, become greater maſters in the art than any others, even where the ſenſation is more delicate and fine*. It is from this habit, therefore, and their peculiar formation, and not, as is ſuppoſed, from their being furniſhed with a greater quantity of nerves, that the fingers are thus perfectly qualified to judge of forms. Blind men, who are obliged to uſe them much oftener, have this ſenſe much finer; ſo that the delicacy of the touch ariſes rather from the habit of conſtantly employing the fingers, than from any fancied nervouſneſs in their conformation.

All animals that are furniſhed with hands † ſeem to have more underſtanding than others. Monkeys have ſo many actions like thoſe of men, that they appear to have ſimilar ideas of the form of bodies. All other creatures, deprived of hands, can have no diſtinct ideas of the ſhape of the objects by which they are ſurrounded, as they want this organ, which ſerves to examine and meaſure their forms, their riſings and depreſſions. A quadruped, probably, conceives as erroneous an idea of any thing near him, as a child would of a rock or a mountain that it beheld at a diſtance. It may be for this reaſon, that we often ſee them frighted at things with which they ought to be better acquainted.—Fiſhes, whoſe bodies are covered with ſcales, and who have no organs for feeling, muſt be the moſt ſtupid of all animals. Serpents, that are likewiſe deſtitute, are yet, by winding round ſeveral bodies, better capable of judging of their form. All theſe, however, can have but very imperfect ideas from feeling; and we have already ſeen, when deprived of this ſenſe, how little the reſt of the ſenſes are to be relied on.

The feeling, therefore, is the guardian, the judge, and the examiner of all the reſt of the ſenſes. It eſtabliſhes their information, and detects their errors. All the other ſenſes are altered by time, and contradict their former evidence; but the touch ſtill continues the ſame; and, though extremely confined in its operations, yet it is never found to deceive. The univerſe, to a man who had only uſed the reſt of his ſenſes, would be but a ſcene of illuſion; every object miſrepreſented, and all its properties unknown. Mr. Buffon has imagined a man juſt newly brought into exiſtence, deſcribing the illuſion of his firſt ſenſations, and pointing out the ſteps by which he arrived at reality. He conſiders him as juſt created, and awaking amidſt the productions of Nature; and, to animate the narrative ſtill more ſtrongly, has made his philoſophical man a ſpeaker. The reader will no doubt recollect Adam's ſpeech in Milton as being ſimilar.—All that I can ſay to obviate the imputation of plagiariſm is, that the one treats the ſubject more as a poet, the other more as a philoſopher. The philoſopher's man deſcribes his firſt ſenſations in the following manner *.

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* Buffon, vol. vi. p. 80.

† Ibid. vol. vi. p. 82.

I well remember that joyful anxious moment when I firſt became acquainted with my own exiſtence. I was quite ignorant of what I was, how I was produced, or from whence I came. I opened my eyes: what an addition to my ſurpriſe! the light of the day, the azure vault of heaven, the verdure of the earth, the cryſtal of the waters, all employed me at once, and animated and filled me with inexpreſſible delight. I at firſt imagined that all thoſe objects were within me, and made a part of myſelf.

Impreſſed with this idea, I turned my eyes to the ſun; its ſplendor dazzled and overpowered me: I ſhut them once more; and, to my great concern, I ſuppoſed that, during this ſhort interval of darkneſs, I was again returning to nothing.

Afflicted, ſeized with aſtoniſhment, I pondered a moment on this great change, when I heard a variety of unexpected ſounds. The whiſtling of the wind, and the melody of the grove, formed a concert, the ſoft cadence of which ſunk upon my ſoul. I liſtened for ſome time, and was perſuaded that all this muſic was within me.

Quite occupied with this new kind of exiſtence, I had already forgtten the light which was my firſt inlet into life;

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* Buffon, vol. vi. p. 88.

when I once more opened my eyes, and found myſelf again in poſſeſſion of my former happineſs. The gratification of the two ſenſes at once, was a pleaſure too great for utterance.

I turned my eyes upon a thouſand various objects; I ſoon found that I could loſe them, and reſtore them at will; and amuſed myſelf more at leiſure with a repetition of this new-made power.

I now began to gaze without emotion, and to hearken with tranquillity, when a light breeze, the freſhneſs of which charmed me, wafted its perfumes to my ſenſe of ſmelling, and gave me ſuch ſatisfaction as even increaſed my ſelf-love.

Agitated, rouzed by the various pleaſures of my new exiſtence, I inſtantly aroſe, and perceived myſelf moved along, as if by ſome unknown and ſecret power.

I had ſcarce proceeded forward, when the novelty of my ſituation once more rendered me immoveable. My ſurpriſe returned; I ſuppoſed that every object around me had been in motion: I gave to them that agitation which I produced by changing place; and the whole creation ſeemed once more in diſorder.

I lifted my hand to my head; I touched my forehead; I felt my whole frame; I then ſuppoſed that my hand was the principal organ of my exiſtence; all its informations were diſtinct and perfect; and ſo ſuperior to the ſenſes I had yet experienced, that I employed myſelf for ſome time in repeating its enjoyments: every part of my perſon I touched, ſeemed to touch my hand in turn; and gave back ſenſation for ſenſation.

I ſoon found, that this faculty was expanded over the whole ſurface of my body; and I now firſt began to perceive the limits of my exiſtence, which I had in the beginning ſuppoſed ſpread over all the objects I ſaw.

Upon caſting my eyes upon my body, and ſurveying my own form, I thought it greater than all the objects that ſurrounded me. I gazed upon my perſon with pleaſure; I examined the formation of my hand, and all its motions; it ſeemed to me large or little in proportion as I approached it to my eyes; I brought it very near, and it then hid almoſt every other object from my ſight. I began ſoon, however, to find that my ſight gave me uncertain information, and reſolved to depend upon my feeling for redreſs.

This precaution was of the utmoſt ſervice; I renewed my motions, and walked forward with my face turned towards the heavens. I happened to ſtrike lightly againſt a palm-tree, and this renewed my ſurpriſe: I laid my hand on this ſtrange body; it ſeemed replete with new wonders, for it did not return me ſenſation for ſenſation, as my former feelings had done I perceived that there was ſomething external, and which did not make a part of my own exiſtence.

I now, therefore, reſolved to touch whatever I ſaw, and vainly attempted to touch the ſun; I ſtretched forth my arm, and felt only yielding air: at every effort, I fell from one ſurpriſe into another, for every object appeared equally near me; and it was not till after an infinity of trials, that I found ſome objects further removed than the reſt.

Amazed with the illuſions, and the uncertainty of my ſtate, I ſat down beneath a tree; the moſt beautiful fruits hung upon it, within my reach; I ſtretched forth my hand, and they inſtantly ſeparated from the branch. I was proud of being able to graſp a ſubſtance without me; I held them up, and their weight appeared to me like an animated power that endeavoured to draw them to the earth. I found a pleaſure in conquering their reſiſtance.

I held them near my eye; I conſidered their form and beauty; their fragrance ſtill more allured me to bring them nearer, I approached them to my lips, and drank in their odours; the perfume invited my ſenſe of taſting, and I ſoon tried a new ſenſe—How new! how exquiſite! Hitherto I had taſted only of pleaſure; but now it was luxury. The power of taſting gave me the idea of poſſeſſion.

Flattered with this new acquiſition, I continued its exerciſe, till an agreeable languor ſtealing upon my mind, I felt all my limbs become heavy, and all my deſires ſuſpended. My ſenſations were now no longer vivid and diſtinct; but ſeemed to loſe every object, and preſented only feeble images, confuſedly marked.. At that inſtant I ſunk upon the flowery bank, and ſlumber ſeized me. All now ſeemed once more loſt to me. It was then as if I was returning into my former nothing. How long my ſleep continued, I cannot tell; as I yet had no perception of time. My awaking appeared like a ſecond birth; and I then perceived that I had ceaſed for a time to exiſt. This produced a new ſenſation of fear; and from this interruption in life, I began to conclude that I was not formed to exiſt for ever.

In this ſtate of doubt and perplexity, I began to harbour new ſuſpicions; and to fear that ſleep had robbed me of ſome of my late powers; when, turning on one ſide, to reſolve my doubts, what was my amazement, to behold another being, like myſelf, ſtretched by my ſide! New ideas now began to ariſe; new paſſions, as yet unperceived, with fears, and pleaſures, all took poſſeſſion of my mind, and prompted my curioſity: love ſerved to complete that happineſs which was begun in the individual; and every ſenſe was gratified in all its varieties.

CHAP. X.

OF OLD AGE AND DEATH*.

EVERY thing in Nature has its improvement and decay. The human form is no ſooner arrived at its ſtate of perfection than it begins to decline. The alteration is, at firſt, inſenſible; and, often, ſeveral years are elapſed before we find ourſelves grown old. The news of this diſagreeable change, too generally comes from without; and we learn from others that we grow old, before we are willing to believe the report.

When the body has come to its full height, and is extended into its juſt dimenſions; it then alſo begins to receive an additional bulk, which rather loads than aſſiſts it. This is formed from fat; which generally, at the age of thirty-five, or forty, covers all the muſcles, and interrupts their activity.

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* This chapter is taken from Mr. Buffon, except where it is marked by inverted commas.

Every action is then performed with greater labour, and the increaſe of ſize only ſerves as a forerunner of decay.

The bones, alſo, become every day more ſolid. In the embryo they are as ſoft almoſt as the muſcles and the fleſh; but, by degrees, they harden, and acquire their natural vigour; but ſtill, however, the circulation is carried on through them, and, how hard ſoever the bones may ſeem, yet the blood holds its current through them as through all other parts of the body. Of this we may be convinced, by an experiment, which was firſt accidentally diſcovered, by our ingenious countryman Mr. Belcher. Perceiving at a friend's houſe, that the bones of hogs, which were fed upon madder, were red, he tried it upon various animals, by mixing this root with their uſual food; and he found that it tinctured the bones in all; an evident demonſtration that the juices of the body had a circulation through the bones. He fed ſome animals alternately upon madder and their common food, for ſome time, and he found their bones tinctured with alternate layers, in conformity to their manner of living. From all this he naturally concluded, that the blood circulated through the bones as is does through every other part of the body; and that, how ſolid ſoever they ſeemed, yet, like the ſofteſt parts, they were furniſhed, through all their ſubſtance, with their proper canals. Neverthelefs, theſe canals are of very different capacities, during the different ſtages of life. In infancy they are capacious; and the blood flows almoſt as freely through the bones as through any other part of the body; in manhood their ſize is greatly diminiſhed; the veſſels are almoſt imperceptible; and the circulation through them is proportionably ſlow. But, in the decline of life, the blood, which flows through the bones, no longer contributing to their growth, muſt neceſſarily ſerve to increaſe their hardneſs. The channels that every where run through the human frame, may be compared to thoſe pipes that we every where ſee cruſted on the inſide, by the water, for a long continuance, running through them. Both every day grow leſs and leſs, by the ſmall rigid particles which are depoſited within them. Thus as the veſſels are by degrees diminiſhed, the juices, alſo, which were neceſſary for the circulation through them, are diminiſhed in proportion;

till at length, in old age, thoſe props of the human frame are not only more ſolid but more brittle.

The cartilages, or griſtles, which may conſidered as bones beginning to be formed, grow alſo more rigid. The juices circulating through them, for there is a circulation through all parts of the body, every day contributes to render them harder; ſo that theſe ſubſtances, which in youth are elaſtic, and pliant, in age, become hard and bony. As theſe cartilages are generally placed near the joints, the motion of the joints alſo muſt, of conſequence, become more difficult. Thus, in old age, every action of the body is performed with labour; and the cartilages, formerly ſo ſupple, will now ſooner break than bend.

" As the cartilages acquire hardneſs, and unfit the joints for motion, ſo alſo that mucous liquor, which is always ſeparated between the joints, and which ſerves, like oil to a hinge, to give them an eaſy and ready play, is now grown more ſcanty. It becomes thicker, and more clammy, more unfit for anſwering the purpoſes of motion; and from thence, in old age, every joint is not only ſtiff, but awkward. At every motion, this clammy liquor is heard to crack; and it is not without the greateſt effort of the muſcles that its reſiſtance is overcome. I have ſeen an old perſon, who never moved a ſingle joint that did not thus give notice of the violence done it."

The membranes that cover the bones, the joints, and the reſt of the body, become, as we grow old, more denſe and more dry. Theſe which ſurround the bones, ſoon ceaſe to be ductile. The fibres, of which the muſcles or fleſh is compoſed, become every day more rigid; and, while to the touch the body ſeems, as we advance in years, to grow ſofter, it is, in reality, increaſing in hardneſs. It is the ſkin, and not the fleſh, that we fell upon ſuch occaſions. The fat, and flabbineſs of that, ſeems to give an appearance of ſoftneſs, which the fleſh itſelf is very far from having. There are few can doubt this, after trying the difference between the fleſh of young and old animals. The firſt is ſoft and tender, the laſt is hard and dry.

The ſkin is the only part of the body that age does not contribute to harden. That ſtretches to every degree of tenſion; and we have horrid inſtances of its pliancy, in many diſorders incident to humanity. In youth, therefore, while the body is vigorous and increaſing, it ſtill gives way to its growth. But, although it thus adapts itſelf to our increaſe, it does not in the ſame manner conform to our decay. The ſkin, which in youth was filled, and gloſſy, when the body begins to decline, has not elaſticity enough to ſhrink entirely with its diminution. It hangs, therefore, in wrinkles, which no art can remove. The wrinkles of the body, in general, proceed from this cauſe. But thoſe of the face ſeem to proceed from another; namely, from the many varieties of poſitions into which it is put by the ſpeech, the food, or the paſſions. Every grimace, and every paſſion wrinkles up the viſage into different forms. Theſe are viſible enough in young perſons; but what at firſt was accidental, or tranſitory, becomes unalterably fixed in the viſage as it grows older. "From hence we may conclude, that a freedom from paſſions not only adds to the happineſs of the mind, but preſerves the beauty of the face; and the perſon that has not felt their influence, is leſs ſtrongly marked by the decays of nature."

Hence, therefore, as we advance in age, the bones, the cartilages, the membranes, the fleſh, the ſkin, and every fibre of the body, become more ſolid, more brittle, and more dry. Every part ſhrinks, every motion becomes more ſlow; the circulation of the fluids is performed with leſs freedom; perſpiration diminiſhes; the ſecretions alter; the digeſtion becomes ſlow and laborious; and the juices no longer ſerving to convey their accuſtomed nouriſhment, thoſe parts may be ſaid to live no longer when the circulation ceaſes. Thus the body dies by little and little; all its functions are diminiſhed by degrees; life is driven from one part of the frame to another; univerſal rigidity prevails; and death at laſt ſeizes upon the little that is left.

As the bones, the cartilages, the muſcles, and all other parts of the body, are ſofter in women than in men, theſe parts muſt, of conſequence, require a longer time to come to that hardneſs which haſtens death. Women, therefore, ought to be a longer time in growing old than men; and this is actually the caſe. If we conſult the tables which have been drawn up reſpecting human life, we ſhall find, that, after a certain age, they are more long-lived than men, all other circumſtances the ſame. A woman of ſixty has a better chance than a man of the ſame age to live till eighty. Upon the whole, we may infer, that ſuch perſons as have been ſlow in coming up to maturity, will alſo be ſlow in growing old; and this holds as well with regard to other animals as to man.

The whole duration of the life of either vegetables, or animals, may be, in ſome meaſure, determined from their manner of coming to maturity. The tree, or the animal, which takes but a ſhort time to increaſe to its utmoſt pitch, periſhes much ſooner than ſuch as are leſs premature. In both, the increaſe upwards is firſt accompliſhed; and not till they have acquired their greateſt degree of height do they begin to ſpread in bulk. Man grows in ſtature till about the age of ſeventeen; but his body is not completely developed till about thirty. Dogs, on the other hand, are at their utmoſt ſize, in a year, and become as bulky as they uſually are in another. However, man, who is ſo long in growing, continues to live for fourſcore, or a hundred years; but the dog ſeldom above twelve or thirteen. In general, alſo, it may be ſaid, that large animals live longer than little ones, as they uſually take a longer time to grow. But in all animals, one thing is equally certain, that they carry the cauſes of their own decay about them; and that their deaths are neceſſary and inevitable. The proſpects which ſome viſionaries have formed of perpetuating life by remedies, have been often enough proved falſe, by their own example. Such unaccountable ſchemes would, therefore, have died with them, had not the love of life always augmented our credulity.

When the body is naturally well formed, it is poſſible to lengthen out the period of life for ſome years by management. Temperance in diet is often found conducive to this end. The famous Cornaro, who lived to above a hundred years, although his conſtitution was naturally feeble, is a ſtrong inſtance of the benefit of an abſtemious life. Moderation in the paſſions alſo may contribute to extend the term of our exiſtence. "Fontenelle, the celebrated writer, was naturally of a very weak and delicate habit of body. He was affected by the ſmalleſt irregularities; and had frequently ſuffered ſevere fits of illneſs from the ſlighteſt cauſes. But the remarkable equality of his temper, and his ſeeming want of paſſion, lengthened out his life to above a hundred. It was remarkable of him, that nothing could vex or make him uneaſy; every occurrence ſeemed equally pleaſing; and no event, however unfortunate, ſeemed to come unexpected." However, the term of life can be prolonged but for a very little time by any art we can uſe. We are told of men who have lived beyond the ordinary duration of human exiſtence; ſuch as Parr, who lived to a hundred and forty-four; and Jenkins to a hundred and ſixty-five; yet theſe men uſed no peculiar arts to prolong life; on the contrary, it appears that theſe, as well as ſome others, remarkable for their longevity, were peaſants accuſtomed to the greateſt fatigues, who had no ſettled rules of diet, but who often indulged in accidental exceſſes. Indeed, if we conſider that the European, the Negro, the Chineſe, and the American, the civilized man, and the ſavage, the rich and the poor, the inhabitant of the city and of the country, though all ſo different in other reſpects, are yet entirely ſimilar in the period allotted them for living; if we conſider that neither the difference of race, of climate, of nouriſhment, of convenience, or of ſoil, makes any difference in the term of life; if we conſider that thoſe men who live upon raw fleſh, or dried fiſhes, upon ſago, or rice, upon caſſava, or upon roots, nevertheleſs live as long as thoſe who are fed upon bread and meat, we ſhall readily be brought to acknowledge, that the duration of life depends neither upon habit, cuſtoms, nor the quantity of food; we ſhall confeſs, that nothing can change the laws of that mechaniſm which regulates the number of our years, and which can chiefly be affected only by long faſting or great exceſs.

If there be any difference in the different periods of man's exiſtence, it ought principally to be aſcribed to the quality of the air. It has been obſerved, that in elevated ſituations there have been found more old people than in thoſe that were low. The mountains of Scotland, Wales, Auvergne, and Switzerland, have furniſhed more inſtances of extreme old age, than the plains of Holland, Flanders, Germany, or Poland. But, in general, the duration of life is nearly the ſame in moſt countries. Man, if not cut off by accidental diſeaſes, is often found to live to ninety or a hundred years. Our anceſtors did not live beyond that date; and, ſince the times of David, this term has undergone little alteration.

If we be aſked, how in the beginning men lived ſo much longer than at preſent, and by what means their lives were extended to nine hundred and thirty, or even nine hundred and ſixty years? It may be anſwered, that the productions of the earth, upon which they fed, might be of a different nature at that time from what they are at preſent. "It may be anſwered, that the term was abridged by Divine Command, in order to keep the earth from being overſtocked with human inhabitants; ſince, if every perſon were now to live and generate for nine hundred years, mankind would be increaſed to ſuch a degree, that there would be no room for ſubſiſtence: ſo that the plan of Providence would be altered; which is ſeen not to produce life, without providing a proper ſupply."

But to whatever extent life may be prolonged, or however ſome may have delayed the effects of age, death is the certain goal to which all are haſtening. All the cauſes of decay which have been mentioned, contribute to bring on this dreaded diſſolution. However, Nature approaches to this awful period, by ſlow and imperceptible degrees; life is conſuming day after day; and ſome one of our faculties, or vital principles is every hour dying before the reſt; ſo that death is only the laſt ſhade in the picture; and it is probable that man ſuffers a greater change in going from youth to age, than from age into the grave. When we firſt begin to live, our lives may ſcarcely be ſaid to be our own; as the child grows, life increaſes in the ſame proportion; and is at its height in the prime of manhood. But as ſoon as the body begins to decreaſe, life decreaſes alſo; for, as the human frame diminiſhes, and its juices circulate in ſmaller quantity, life diminiſhes and circulates with leſs vigour; ſo that as we begin to live by degrees, we begin to die in the ſame manner.

Why then ſhould we fear death, if our lives have been ſuch as not to make eternity dreadful? Why ſhould we fear that moment which is prepared by a thouſand other moments of the ſame kind? the firſt pangs of ſickneſs being probably greater than the laſt ſtruggles of departure. Death, in moſt perſons, is as calmly endured as the diſorder that brings it on. If we inquire from thoſe whoſe buſineſs it is to attend the ſick and the dying, we ſhall find that, except in a very few acute caſes, where the patient dies in agonies, the greateſt number die quietly, and ſeemingly without pain: and even the agonies of the former rather terrify the ſpectators than torment the patient; for how many have we not ſeen who have been accidentally relieved from this extremity, and yet had no memory of what they then endured? In fact, they had ceaſed to live, during that time when they ceaſed to have ſenſation; and their pains were only thoſe of which they had an idea.

The greateſt number of mankind die, therefore, without ſenſation; and of thoſe few that ſtill preſerve their faculties entire to the laſt moment, there is ſcarce one of them that does not alſo preſerve the hopes of ſtill out-living his diſorder. Nature, for the happineſs of man, has rendered this ſentiment ſtronger than his reaſon. A perſon dying of an incurable diſorder, which he muſt know to be ſo, by frequent examples of his caſe; which he perceives to be ſo, by the inquietude of all around him, by the tears of his friends, and the departure or the face of the phyſician, is nevertheleſs, ſtill in hopes of getting over it. His intereſt is ſo great, that he only attends to his own repreſentations; the judgment of others is conſidered as a haſty concluſion; and while death every moment makes new inroads upon his conſtitution, and deſtroys life in ſome part, hope ſtill ſeems to eſcape the univerſal ruin, and is the laſt that ſubmits to the blow.

Caſt your eyes upon a ſick man, who has a hundred times told you that he felt himſelf dying, that he was convinced he could not recover, and that he was ready to expire; examine what paſſes on his viſage, when, through zeal or indiſcretion, any one comes to tell him that his end is at hand. You will ſee him change, like one who is told an unexpected piece of news. He now appears not to have thoroughly believed what he had been telling you himſelf; he doubted much; and his fears were greater than his hopes; but he ſtill had ſome feeble expectations of living, and would not have ſeen the approaches of death, unleſs he had been alarmed by the miſtaken aſſiduity of his attendants.

Death, therefore, is not that terrible thing which we ſuppoſe it to be. It is a ſpectre which frights us at a diſtance, but which diſappears when we come to approach it more cloſely. Our ideas of its terrors are conceived in prejudice, and dreſſed up by fancy; we regard it not only as the greateſt misfortune, but as alſo an evil accompanied with the moſt excruciating tortures: we have even increaſed our apprehenſions, by reaſoning on the extent of our ſufferings. "It muſt be dreadful," ſay ſome, "ſince it is ſufficient to ſeparate the ſoul from the body; it muſt be long, ſince our ſufferings are proportioned to the ſucceſſion of our ideas; and theſe being painful, muſt ſucceed each other with extreme rapidity." In this manner has falſe philoſophy laboured to augment the miſeries of our nature; and to aggravate that period, which Nature has kindly covered with inſenſibility. Neither the mind nor the body can ſuffer theſe calamities; the mind is, at that time, moſtly without ideas; and the body too much enfeebled, to be capable of perceiving its pain. A very acute pain produces either death, or fainting, which is a ſtate ſimilar to death: the body can ſuffer but to a certain degree; if the torture becomes exceſſive, it deſtroys itſelf; and the mind ceaſes to perceive, when the body can no longer endure.

In this manner, exceſſive pain admits of no reflection; and wherever there are any ſigns of it, we may be ſure that the ſufferings of the patient are no greater than what we ourſelves may have remembered to endure.

But, in the article of death, we have many inſtances in which the dying perſon has ſhewn that very reflection which preſuppoſes an abſence of the greateſt pain; and, conſequently, that pang which ends life, cannot even be ſo great as thoſe which have preceded. Thus, when Charles XII. was ſhot at the ſiege of Frederickſhall, he was ſeen to clap his hand on the hilt of his ſword; and although the blow was great enough to terminate one of the boldeſt and braveſt lives in the world, yet it was not painful enough to deſtroy reflection. He perceived himſelf attacked; he reflected that he ought to defend himſelf, and his body obeyed the impulſe of his mind, even in the laſt extremity. Thus it is the prejudice of perſons in health, and not the body in pain, that makes us ſuffer from the approach of death: we have all our lives contracted a habit of making out exceſſive pleaſures and pains; and nothing but repeated experience ſhews us, how ſeldom the one can be ſuffered; or the other enjoyed to the utmoſt.

If there be any thing neceſſary to confirm what we have ſaid, concerning the gradual ceſſation of life, or the inſenſible approaches of our end, nothing can more effectually prove it, than the uncertainty of the ſigns of death. If we conſult what Winſlow or Bruhier have ſaid upon this ſubject, we ſhall be convinced, that between life and death, the ſhade is ſo very undiſtinguiſhable, that even all the powers of art can ſcarcely determine where the one ends, and the other begins. The colour of the viſage, the warmth of the body, the ſupplenefs of the joints, are but uncertain ſigns of life ſtill ſubſiſting; while, on the contrary, the paleneſs of the complexion, the coldneſs of the body, the ſtiffneſs of the extremities, the ceſſation of all motion, and the total inſenſibility of the parts, are but uncertain marks of death begun. In the ſame manner, alſo, with regard to the pulſe, and the breathing, theſe motions are often ſo kept under, that it is impoſſible to perceive them. By approaching a looking-glaſs to the mouth of the perſon ſuppoſed to be dead, people often expect to find whether he breathes or not. But this is a very uncertain experiment: the glaſs is frequently ſullied by the vapour of the dead man's body; and often the perſon is ſtill alive, although the glaſs is no way tarniſhed. In the ſame manner, neither burning nor ſcarifying, neither noiſes in the ears nor pungent ſpirits applied to the noſtrils, give certain ſigns of the diſcontinuance of life; and there are many inſtances of perſons who have endured them all, and afterwards recovered without any external aſſiſtance, to the aſtoniſhment of the ſpectators. How careful, therefore, ſhould we be, before we commit thoſe who are deareſt to us to the grave, to be well aſſured of their departure: experience, juſtice, humanity, all perſuade us not to haſten the funerals of our friends, but to keep their bodies unburied, until we have certain ſigns of their real deceaſe.

CHAP. XI.

OF THE VARIETIES IN THE HUMAN RACE.

HITHERTO we have compared man with other animals; we now come to compare men with each other. We have hitherto conſidered him as an individual, endowed with excellencies above the reſt of the creation; we now come to conſider the advantages which men have over men, and the various kinds with which our earth is inhabited.

If we compare the minute differences of mankind, there is ſcarce one nation upon the earth that entirely reſembles another; and there may be ſaid to be as many different kinds of men as there are countries inhabited. One poliſhed nation does not differ more from another, than the mereſt ſavages do from thoſe ſavages that lie even contiguous to them; and it frequently happens that a river, or a mountain, divides two barbarous tribes that are unlike each other in manners, cuſtoms, features, and complexion. But theſe differences, however, perceivable, do not form ſuch diſtinctions as come within a general picture of the varieties of mankind. Cuſtom, accident, or faſhion, may produce conſiderable alterations in neighbouring nations; their being derived from anceſtors of a different climate, or complexion, may contribute to make accidental diſtinctions, which every day grow leſs; and it may be ſaid, that two neighbouring nations, how unlike ſoever at firſt, will aſſimilate by degrees; and, by long continuance, the difference between them will at laſt become almoſt imperceptible. It is not, therefore, between contiguous nations we are to look for any ſtrong marked varieties in the human ſpecies; it is by comparing the inhabitants of oppoſite climates and diſtant countries; thoſe who live within the polar circle with thoſe beneath the equator; thoſe that live on one ſide of the globe with thoſe that occupy the other.

Of all animals, the differences between mankind are the ſmalleſt. Of the lower races of creatures, the changes are ſo great as often entirely to diſguiſe the natural animal, and to diſtort, or disfigure its ſhape. But the chief differences in man are rather taken from the tincture of his ſkin than the variety of his figure; and in all climates he preſerves his erect deportment and the marked ſuperiority of his form. If we look round the world there ſeem to be not above ſix diſtinct varieties in the human ſpecies, each of which is ſtrongly marked, and ſpeaks the kind ſeldom to have mixed with any other*. But there is nothing in the ſhape, nothing in the faculties, that ſhews their coming from different originals; and the varieties of climate, of nouriſhment, and cuſtom, are ſufficient to produce every change.

The firſt diſtinct race of men is found round the polar regions. The Laplanders, the Eſquimaux Indians, the Samoid Tartars, the inhabitants of Nova Zembla, the Borandians, the Greenlanders, and the natives of Kamtſchatka, may be conſidered as one peculiar race of people, all greatly reſembling each other in their ſtature, their complexion, their cuſtoms, and their ignorance. Theſe nations being under a rigorous climate, where the productions of Nature are but few, and the proviſions coarſe and unwholeſome, their bodies have ſhrunk to the nature of their food; and their complexions have ſuffered, from cold, almoſt a ſimilar change to what heat is known to produce; their colour being a deep brown, in ſome places inclining to actual blackneſs. Theſe, therefore, in general, are found to be a race of ſhort ſtature and odd ſhape, with countenances as ſavage as their manners are barbarous. The viſage, in theſe countries, is large and broad, the noſe flat and ſhort, the eyes of a yellowiſh brown, inclining to blackneſs, the eye-lids drawn towards the temples, the cheek-bones extremely high, the mouth very large, the lips thick, and turned outwards, the voice thin and ſqueaking, the head large, the hair black and ſtraight, the colour of the ſkin of a dark greyiſh†. They are ſhort in ſtature, the generality not being above four feet high, and the talleſt not above five. Among all theſe nations the women are as deformed as the men, and reſemble them ſo nearly, that one cannot at firſt diſtinguiſh the ſexes among them.

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* I have taken four of theſe varieties from Linnæus; thoſe of the Laplanders and Tartars from Mr. Buffon.

† Krantz.

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Theſe nations not only reſemble each other in their deformity, their dwarfiſhneſs, the colour of their hair and eyes, but they have, in a great meaſure, the ſame inclinations, and the ſame manners, being all equally rude, ſuperſtitious, and ſtupid. The Daniſh Laplanders have a large black cat, to which they communicate their ſecrets, and conſult in all their affairs. Among the Swediſh Laplanders there is in every family a drum for conſulting the devil; and although theſe nations are robuſt and nimble, yet they are ſo cowardly that they never can be brought into the field. Guſtavus Adolphus attempted to form a regiment of Laplanders, but he found it impoſſible to accompliſh his deſign; for it ſhould ſeem that they can live only in their own country, and in their own manner. They make uſe of ſkates, which are made of fir, of near three feet long, and half a foot broad; theſe are pointed, and raiſed before, and tied to the foot by ſtraps of leather. With theſe they ſkate upon the icy ſnow, with ſuch velocity, that they very eaſily overtake the ſwifteſt animals. They make uſe alſo of a pole, pointed with iron at one end, and rounded at the other. This pole ſerves to puſh them along, to direct their courſe, to ſupport them from falling, to ſtop the impetuoſity of their motion, and to kill that game which they have overtaken. Upon theſe ſkates they deſcend the ſteepeſt mountains, and ſcale the moſt craggy precipices; and, in theſe exerciſes, the women are not leſs ſkilful than the men. They have all the uſe of the bow and arrow, which ſeems to be a contrivance common to all barbarous nations; and which, however, at firſt, required no ſmall ſkill to invent. They launch a javelin, alſo, with great force, and ſome ſay that they can hit a mark, no larger than a crown, at thirty yards diſtance, and with ſuch force as would pierce a man through. They are all hunters; and particularly purſue the ermine, the fox, the ounce, and the martin, for the ſake of their ſkins. Theſe they barter, with their ſouthern neighbours, for brandy and tobacco; both which they are fond of to exceſs. Their food is principally dried fiſh, the fleſh of rein-deer and bears. Their bread is compoſed of the bones of fiſhes, pounded and mixed with the inſide tender bark of the pine-tree. Their drink is train-oil, or brandy; and, when deprived of theſe, water in which juniper berries have been infuſed. With regard to their morals, they have all the virtues of ſimplicity, and all the vices of ignorance. They offer their wives and daughters to ſtrangers; and ſeem to think it a particular honour if their offer be accepted. They have no idea of religion, or a Supreme Being; the greateſt number of them are idolaters; and their ſuperſtitution is as profound as their worſhip is contemptible. Wretched and ignorant as they are, yet they do not want pride; they ſet themſelves far above the reſt of mankind; and Krantz aſſures us, that when the Greenlanders are got together, nothing is ſo cuſtomary among them as to turn the Enropeans into ridicule. They are obliged, indeed, to yield them the pre-eminence in underſtanding and mechanic arts; but they do not know how to ſet any value upon theſe. They therefore count themſelves the only civilized and well-bred people in the world; and it is common with them, when they ſee a quiet, or a modeſt ſtranger, to ſay that he is almoſt as well bred as a Greenlander.

From this deſcription, therefore, this whole race of people may be conſidered as diſtinct from any other. Their long continuance in a climate the moſt inhoſpitable, their being obliged to ſubſiſt on food the moſt coarſe and ill prepared, the ſavageneſs of their manners, and their laborious lives, all have contributed to ſhorten their ſtature, and to deform their bodies*. In proportion as we approach towards the north pole, the ſize of the natives appear to diminiſh, growing leſs and leſs as we advance higher, till we come to thoſe latitudes that are deſtitute of all inhabitants whatſoever.

The wretched natives of theſe climates ſeem fitted by Nature to endure the rigours of their ſituation. As their food is but ſcanty and precarious, their patience in hunger is amazing†. A man, who has ate nothing for four days, can manage his little canoe, in the moſt furious waves, and calmly ſubſiſt in the midſt of a tempeſt, that would quickly daſh a European boat to pieces. Their ſtrength is not leſs amazing than their patience; a women among them will carry a piece of timber, or a ſtone, near double the weight of what a European can lift. Their bodies are of a dark grey all over; and their faces brown, or olive. The tincture of their ſkins partly ſeems to ariſe from their dirty manner of living, being generally daubed with train-oil; and partly from the rigours of climate, as the ſudden alterations of cold and raw air in winter, and of burning heats in ſummer, ſhade their complexions by degrees, till, in a ſucceſſion of generations, they at laſt become almoſt black. As the countries in which theſe reſide are the moſt barren, ſo the natives ſeem the moſt barbarous of any part of the earth. Their more ſouthern neighbours of America, treat them with the ſame ſcorn that a poliſhed nation would treat a ſavage one; and we may readily judge of the rudeneſs of thoſe manners, which even a native of Canada can think more barbarous than his own.

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* Ellis's Voyage, p. 256.

† Krantz, p. 134, vol. i.

But the gradations of Nature are imperceptible; and, while the north is peopled with ſuch miſerable inhabitants, there are here and there to be found, upon the edges of theſe regions, people of larger ſtature, and completer figure. A whole race of the dwarfiſh breed is often found to come down from the north, and ſettle more to the ſouthward; and, on the contrary, it ſometimes happens that ſouthern nations are ſeen higher up, in the midſt of theſe diminutive tribes, where they have continued for time immemorial. Thus the Oſtiac Tartars ſeem to be a race that have travelled down from the north, and to be originally ſprung from the minute ſavages we have been deſcribing. There are alſo Norwegians and Finlanders, of proper ſtature, who are ſeen to inhabit in latitudes higher even than Lapland. Theſe, however, are but accidental migrations, and ſerve as ſhades to unite the diſtinct varieties of mankind.

The ſecond great variety in the human ſpecies, ſeems to be that of the Tartar race; from whence, probably, the little men we have been deſcribing originally proceeded. The Tartar country, taken in general, comprehends the greateſt part of Aſia; and is, conſequently, a general name given to a number of nations, of various forms and complexions. But, however they ſeem to differ from each other, they all agree in being very unlike the people of any other country. All theſe nations have the upper part of the viſage very broad, and wrinkled even while yet in their youth. Their noſes are ſhort and flat, their eyes little, and ſunk in their heads; and, in ſome of them, they are ſeen five or ſix inches aſunder. Their cheek-bones are high, the lower part of their viſage narrow, the chin long and advanced forward, their teeth of an enormous ſize, and growing ſeparate from each other, their eye-brows thick, large, and covering their eyes; their eye-lids thick, the face broad and flat, the complexion olive-coloured, and the hair black. They are of a middle ſize, extremely ſtrong, and very robuſt. They have but little beard, which grows ſtragglingly on the chin. They have large thighs, and ſhort legs. The ugliest of all are the Calmucks, in whoſe appearance there ſeems to be ſomething frightful. They all lead an erratic life, remaining under tents of hair, or ſkins. They live upon horſe fleſh and that of camels, either raw or a little ſodden between the horſe and the ſaddle. They eat alſo fiſh dried in the ſun. Their moſt uſual drink is mares' milk fermented with millet ground into meal. They all have the head ſhaven, except a lock of hair, on the top, which they let grow ſufficiently long to form into treſſes, on each ſide of the face. The women, who are as ugly as the men, wear their hair, which they bind up with bits of copper and other ornaments of a like nature. The majority of theſe nations have no religion, no ſettled notions of morality, no decency of behaviour. They are chiefly robbers: and the natives of Dageſtan, who live near their more poliſhed neighbours, make a traffic of Tartar ſlaves who have been ſtolen, and ſell them to the Turks and the Perſians. Their chief riches conſiſt in horſes, of which perhaps there are more in Tartary, than in any other part of the word. The natives are taught by cuſtom to live in the ſame place with their horſes; they are continually employed in managing them, and at laſt bring them to ſuch great obedience, that the horſe ſeems actually to underſtand the rider's intention.

To this race of men alſo, we muſt refer the Chineſe and the Japaneſe, however different they ſeem in their manners and ceremonies. It is the form of the body that we are now principally conſidering; and there is, between theſe countries, a ſurpriſing reſemblance. It is in general allowed that the Chineſe have broad faces, ſmall eyes, flat noſes, and

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ſcarce any beard; that they are broad and ſquare ſhouldered, and rather leſs in ſtature than Europeans. Theſe are marks common to them and the Tartars, and they may, therefore, be conſidered as being derived from the ſame original. "I have obſerved," ſays Chardin, "that in all the people from the eaſt and the north of the Caſpian ſea, to the peninſula of Malacca, that the lines of the face, and the formation of the viſage, is the ſame. This has induced me to believe, that all theſe nations are derived from the ſame original, however different either their complexions or their manners may appear: for as to the complexion, that proceeds entirely from the climate and the food; and as to the manners, theſe are generally the reſult of their different degrees of wealth or power." That they come from one ſtock, is evident alſo, from this; that the Tartars who ſettle in China, quickly reſemble the Chineſe; and, on the contrary, the Chineſe who ſettle in Tartary, ſoon aſſume the figure, and the manners, of the Tartars.

The Japaneſe ſo much reſemble the Chineſe, that one cannot heſitate to rank them in the ſame claſs. They only differ in being rather browner, as they inhabit a more ſouthern climate. They are, in general, deſcribed, as of a brown complexion, a ſhort ſtature, a broad flat face, a very little beard, and black hair. Their cuſtoms and ceremonies are nearly the ſame; their ideas of beauty ſimilar; and their artificial deformities of blackening the teeth, and bandaging the feet, entirely alike in both countries. They both, therefore, proceed from the ſame ſtock; and although they differ very much from their brutal progenitors, yet they owe their civilization wholly to the mildneſs of the climate in which they reſide, and to the peculiar fertility of the ſoil. To this tribe alſo, we may refer the Cochin Chineſe, the Siameſe, the Tonquineſe, and the inhabitants of Aracan, Laos, and Pegu, who, though all differing from the Chineſe, and each other, nevertheleſs, have too ſtrong a reſemblance, not to betray their common original.

Another, which makes the third variety in the human ſpecies, is that of the ſouthern Aſiatics; the form of whoſe features and perſons may be eaſily diſtinguiſhed from thoſe of the Tartar races. The nations that inhabit the peninſula of India, ſeem to be the principal ſtock from whence the inhabitants of the iſlands that lie ſcattered in the Indian ocean, have been peopled. They are, in general, of a ſlender ſhape, with long ſtrait black hair, and often with Roman noſes. Thus they reſemble the Europeans in ſtature and features; but greatly differ in colour and habit of body. The Indians are of an olive colour, and, in the more ſouthern parts, quite black; although the word Mogul, in their language, ſignifies a white man. The women are extremely delicate, and bathe very often: they are of an olive colour, as well as the men; their legs and thighs are long, and their bodies ſhort, which is the oppoſite to what is ſeen among the women of Europe. They are, as I am aſſured, by no means ſo fruitful as the European women; but they feel the pains of child birth with much leſs ſenſibility, and are generally up and well the day following. In fact, theſe pains ſeem greateſt in all countries where the women are moſt delicate, or the conſtitution enfeebled by luxury or indolence. The women of ſavage nations ſeem, in a great meaſure, exempt from painful labours; and even the hard-working wives of the peaſants among ourſelves, have this advantage, from a life of induſtry, that their child-bearing is leſs painful. Over all India, the children arrive ſooner at maturity, than with us of Europe. They often marry, and conſummate, the huſband at ten years old, and the wife at eight; and they frequently have children at that age. However, the woman who are mothers ſo ſoon, ceaſe bearing before they are arrived at thirty; and, at that time, they appear wrinkled, and ſeem marked with all the deformities of age. The Indians have long been remarkable for their cowardice and effeminacy; every conqueror that has but attempted the invaſion of their country, having ſucceeded. The warmth of the climate entirely influences their manners; they are ſlothful, ſubmiſſive, and luxurious; ſatisfied with ſenſual happineſs alone, they find no pleaſure in thinking; and contented with ſlavery, they are ready to obey any maſter. Many tribes among them eat nothing that has life; they are fearful of killing the meaneſt inſect; and have even erected hoſpitals for the maintenance of all kinds of vermin. The Aſiatic dreſs is a looſe flowing garment, rather fitted for the

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purpoſes of peace and indolence, than of induſtry or war. The vigour of the Aſiatics is, in general, conformable to their dreſs and nouriſhment: fed upon rice, and clothed in effeminate ſilk veſtments, their ſoldiers are unable to oppoſe the onſet of a European army; and, from the times of Alexander to the preſent day we have ſcarce any inſtances of their ſucceſs in arms. Upon the whole, therefore, they may be conſidered as a feeble race of ſenſualiſts, too dull to find rapture in any pleaſures, and too indolent to turn their gravity into wiſdom. To this claſs we may refer the Perſians and Arabians, and, in general, the inhabitants of the iſlands that lie ſcattered in the Indian ocean.

The fourth ſtriking variety in the human ſpecies, is to be found among the Negroes of Africa. This gloomy race of mankind is found to blacken all the ſouthern parts of Africa, from eighteen degrees north of the line, to its extreme termination, at the Cape of Good Hope. I know it is ſaid, that the Caffres, who inhabit the ſouthern extremity of that large continent, are not to be ranked among the Negro race; however, the difference between them, in point of colour and features, is ſo, ſmall, that they may very eaſily be grouped in this general picture; and in the one or two that I have ſeen, I could not perceive the ſmalleſt difference. Each of the Negro nations, it muſt be owned, differ from each other; they have their peculiar countries for beauty, like us; and different nations, as in Europe, pride themſelves upon the regularity of their features. Thoſe of Guinea, for inſtance, are extremely ugly, and have an unſpportable ſcent; thoſe of Moſambique, are reckoned beautiful, and have no ill ſmell whatſoever. The Negroes, in general, are of a black colour, with a ſmooth ſoft ſkin. This ſmoothneſs proceeds from the downy ſoftneſs of the hair which grows upon it; the ſtrength of which gives a roughneſs to the feel, in thoſe of a white complexion. Their ſkins, therefore, have a velvet ſmoothneſs, and ſeem leſs braced upon the muſcles than ours. The hair of their heads differs entirely from what we are accuſtomed to, being ſoft, woolly, and ſhort. The beard alſo, partakes of the ſame qualities; but in this it differs, that it ſoon turns grey, which the hair is ſeldom found to do; ſo that ſeveral are ſeen with white beards, and black hair, at the ſame time. Their eyes are generally of a deep hazle; their noſes flat and ſhort; their lips thick and tumid; and their teeth of an ivory whiteneſs. This their only beauty, however, is ſet off by the colour of their ſkin; the contraſt between the black and white being the more obſervable. It is falſe to ſay that their features are deformed by art; ſince, in the Negro children born in European countries, the ſame deformities are ſeen to prevail; the ſame flatneſs in the noſe; and the ſame prominence in the lips. They are, in general, ſaid to be well ſhaped; but of ſuch as I have ſeen, I never found one that might be juſtly called ſo; their legs being moſtly ill formed, and commonly bending outward on the ſhin-bone. But it is not only in thoſe parts of their bodies that are obvious, that they are diſproportioned; thoſe parts which among us are uſually concealed by dreſs, with them are large and languid[*]. The women's breaſts, after bearing one child, hang down the below the navel; and it is cuſtomary with them to ſuckle the child at their backs, by throwing the breaſt over the ſhoulder. As their perſons are thus naturally deformed, at leaſt to our imaginations, their minds are equally incapable of ſtrong exertions. The climate ſeems to relax their mental powers ſtill more than thoſe of the body; they are, therefore, in general, found to be ſtupid, indolent, and miſchievous. The Arabians themſelves, many colonies of whom have migrated ſouthward into the moſt inland parts of Africa, ſeem to have degenerated from their anceſtors; and forgetting their ancient learning, and loſing their beauty, they have become a race ſcarce any way diſtinguiſhable from the original natives. Nor does it ſeem to have fared otherwiſe with the Portugueſe, who, about two centries ago, ſettled along this coaſt. They alſo are become almoſt as black as the Negroes; and are ſaid by ſome to be even more barbarous.

The inhabitants of America make a fifth race, as different from all the reſt in colour, as they are diſtinct in habitation. The natives of America (except in the northern extremity,

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[*] Linnæus, in primalinea, ſua fæminas Africanas depingit ſicut aliquid deforme in parte genitali geſtantes, quod ſinum pudoris nuncupat. Attamen nihil differunt a noſtratibus in hac parte niſi quod labia pudendæ ſint aliquantulum tumidiora. In hominibus etiam penis eſt longior et multo laxior.

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where they reſemble the Laplanders) are of a red or copper colour; and although, in the old world, different climates produce a variety of complexions and cuſtoms, the natives of the new continent ſeem to reſemble each other in almoſt every reſpect. They are all nearly of one colour, all have black thick ſtraight hair, and thin black beards; which, however, they take care to pluck out by the roots. They have, in general, flat noſes, with high cheek-bones, and ſmall eyes, and theſe deformities of nature they endeavour to increaſe by art: they flatten the noſe, and often the whole head of their children, while the bones are yet ſuſceptible of every impreſſion. They paint the body and face of various colours, and conſider the hair upon any part of it except the head, as a deformity which they are careful to eradicate. Their limbs are generally ſlighter made than thoſe of the Europeans; and I am aſſured, they are far from being ſo ſtrong. All theſe ſavages ſeem to be cowardly; they ſeldom are known to face their enemies in the field, but fall upon them at an advantage; and the greatneſs of their fears ſerves to increaſe the rigours of their cruelty. The wants which they often ſuſtain, make them ſurpriſingly patient in adverſity; diſtreſs, by being grown familiar, becomes leſs terrible; ſo that their patience is leſs the reſult of fortitude than of cuſtom. They have all a ſerious air, although they ſeldom think; and, however cruel to their enemies, are kind and juſt to each other. In ſhort, the cuſtoms of ſavage nations in every country are almoſt the ſame; a wild, independent, and precarious life, produces a peculiar train of virtues and vices: and patience and hoſpitality, indolence and rapacity, content and ſincerity, are found not leſs among the natives of America, than all the the barbarous nations of the globe.

The ſixth and laſt variety of the human ſpecies, is that of the Europeans, and the nations bordering on them. In this claſs we may reckon the Georgians, Circaſſians, and Mingrelians, the inhabitants of Aſia Minor, and the northern parts of Africa, together with a part of thoſe countries which lie north-weſt of the Caſpian ſea. The inhabitants of theſe countries differ a good deal from each other; but they generally agree in the colour of their bodies, the beauty of their complexions, the largeneſs of their limbs, and the vigour of their underſtandings. Thoſe arts which might have had their invention among the other races of mankind, have come to perfection there. In barbarous countries, the inhabitants go either naked, or are awkwardly clothed in furs or feathers; in countries ſemi-barbarous, the robes are looſe and flowing; but here the clothing is leſs made for ſhew than expedition, and unites, as much as poſſible, the extremes of ornament and deſpatch.

To one or other of theſe claſſes, we may refer the people of every country; and as each nation has been leſs viſited by ſtrangers, or has had leſs commerce with the reſt of mankind, we find their perſons, and their manners, more ſtrongly impreſſed with one or other of the characters mentioned above. On the contrary, in thoſe places where trade has long flouriſhed, or where enemies have made many incurſions, the races are uſually found blended, and properly fall beneath no one character. Thus, in the iſlands of the Indian ocean, where a trade has been carried on for time immemorial, the inhabitants appear to be a mixture of all the nations upon the earth; white, olive, brown, and black men, are all ſeen living together in the ſame city, and propagate a mixed breed, that can be referred to none of the claſſes into which naturaliſts have thought proper to divide mankind.

Of all the colours by which mankind is diverſified, it is eaſy to perceive, that ours is not only the moſt beautiful to the eye, but the moſt advantageous. The fair complexion ſeems, if I may ſo expreſs it, as a tranſparent covering to the ſoul; all the variations of the paſſions, every expreſſion of joy or ſorrow, flows to the cheek, and, without language, marks the mind. In the ſlighteſt change of health alſo, the colour of the European face is the moſt exact index, and often teaches us to prevent thoſe diſorders that we do not as yet perceive: not but that the African black, and the Aſiatic olive complexions, admit of their alterations alſo; but theſe are neither ſo diſtinct, nor ſo viſible, as with us; and, in ſome countries, the colour of the viſage is never found to change; but the face continues in the ſame ſettled ſhade in ſhame, and in ſickneſs, in anger, and deſpair.

The colour, therefore, moſt natural to man, ought to be that which is moſt becoming; and it is found, that, in all regions, the children are born fair, or at leaſt red, and that they grow more black, or tawny, as they advance in age. It ſhould ſeem, conſequently, that man is naturally white; ſince the ſame cauſes that darken the complexion in infants, may have originally operated, in ſlower degrees, in blackening whole nations. We could, therefore, readily account for the blackneſs of different nations, did we not ſee the Americans, who live under the line, as well as the Natives of Negroeland, of a red colour, and but a very ſmall ſhade darker than the natives of the northern latitudes, in the ſame continent. For this reaſon, ſome have ſought for other cauſes of blackneſs than the climate; and have endeavoured to prove that the blacks are a race of people, bred from one man, who was marked with accidental blackneſs. This, however, is but mere ungrounded conjecture; and, although the Americans are not ſo dark as the Negroes, yet we muſt ſtill continue in the ancient opinion, that the deepneſs of the colour proceeds from the exceſſive heat of the climate. For, if we compare the heats of Africa with thoſe of America, we ſhall find they bear no proportion to each other. In America, all that part of the continent, which lies under the line, is cool and pleaſant, either ſhaded by mountains, or refreſhed by breezes from the ſea. But, in Africa, the wide tract of country that lies under the line is very extenſive, and the ſoil ſandy; the reflection of the ſun, therefore, from ſo large a ſurface of earth, is almoſt intolerable; and it is not to be wondered at, that the inhabitants ſhould bear, in their looks, the marks of the inhoſpitable climate. In America, the country is but thinly inhabited; and the more torrid tracts are generally left deſert by the inhabitants; for which reaſon they are not ſo deeply tinged by the beams of the ſun. But in Africa the whole face of the country is fully peopled; and the natives are obliged to endure their ſituation, without a power of migration. It is there, conſequently, that they are in a manner tied down to feel all the ſeverity of the heat; and their complexions take the darkeſt hue they are capable of receiving. We need not, therefore, have recourſe to any imaginary propagation, from perſons accidentally black, ſince the climate is a cauſe obvious, and ſufficient to produce the effect.

In fact, if we examine the complexions of different countries, we ſhall find them darken in proportion to the heat of their climate; and the ſhades gradually to deepen as they approach the line. Some nations, indeed, may be found not ſo much tinged by the ſun as others, although they lie nearer the line. But this ever proceeds from ſome accidental cauſes; either from the country lying higher, and conſequently being colder; or from the natives bathing oftener, and leading a more civilized life. In general, it may be aſſerted, that, as we approach the line, we find the inhabitants of each country grow browner, until the colour deepens into perfect blackneſs. Thus, taking our ſtandard from the whiteſt race of people, and beginning with our own country, which, I believe, bids faireſt for the pre-eminence, we ſhall find the French, who are more ſouthern, a ſlight ſhade deeper than we; going farther down, the Spaniards are browner than the French; the inhabitants of Fez darker than they; and the natives of Negroeland the darkeſt of all. In what manner the ſun produces this effect, and how the ſame luminary which whitens wax and linen, ſhould darken the human complexion, is not eaſy to conceive. Sir Thomas Brown firſt ſuppoſed that a mucous ſubſtance, which had ſomething of a vitriolic quality, ſettled under the reticular membrane, and grew darker with heat. Others have ſuppoſed that the blackneſs lay in the epidermis, or ſcarf ſkin, which was burnt up like leather. But nothing has been ſatisfactorily diſcovered upon the ſubject; it is ſufficient that we are aſſured of the fact; and that we have no doubt of the ſun's tinging the complexion in proportion to its vicinity.

But we are not to ſuppoſe that the ſun is the only cauſe of darkening the ſkin; the wind, extreme cold, hard labour, or coarſe and ſparing nouriſhment, are all found to contribute to this effect. We find the peaſants of every country, who are moſt expoſed to the weather, a ſhade darker than the higher ranks of people. The ſavage inhabitants of all places are expoſed ſtill more, and, therefore, contract a ſtill deeper hue; and this will account for the tawny colour of the North American Indians. Although they live in a climate the ſame, or even more northerly than ours, yet they are found to be of complexions very different from thoſe of Europe. But it muſt be conſidered that they live continually expoſed to the ſun; that they uſe many methods to darken their ſkins by art, painting them with red ochre, and anointing them with the fat of bears. Had they taken, for a ſucceſſion of ſeveral generations, the ſame precautions to brighten their colour that an European does, it is very probable that they would in time come to have ſimilar complexions; and, perhaps, diſpute the prize of beauty.

The extremity of cold is not leſs productive of a tawny complexion than that of heat. The natives of the artic circle, as was obſerved, are all brown; and thoſe that lie moſt to the north are almoſt entirely black. In this manner both extremes are unfavourable to the human form and colour, and the ſame effects are produced under the poles that are found at the line.

With regard to the ſtature of the different countries, that ſeems chiefly to reſult from the nature of the food, and the quantity of the ſupply. Not but that the ſeverity of heat or cold, may, in ſome meaſure, diminiſh the growth, and produce a dwarfiſhneſs of make. But, in general, the food is the great agent in producing this effect; where that is ſupplied in large quantities, and, where its quality is wholeſome and nutrimental, the inhabitants are generally ſeen above the ordinary ſtature. On the contrary, where it is afforded in a ſparing quantity, or very coarſe, and void of nouriſhment in its kind, the inhabitants degenerate, and ſink below the ordinary ſize of mankind. In this reſpect they reſemble other animals, whoſe bodies, by proper feeding, may be greatly augmented. An ox, on the fertile plains of India, grows to a ſize four times as large as the diminutive animal of the ſame kind bred in the Alps. The horſes bred in the plains are larger than thoſe of the mountain. So it is with man; the inhabitants of the valley are uſually found taller than thoſe of the hill: the natives of the Highlands of Scotland, for inſtance, are ſhort, broad, and hardy; thoſe of the Lowlands are tall and ſhapely. The inhabitants of Greenland, who live upon dried fiſh and ſeals, are leſs than thoſe of

Gambia or Senegal, where Nature ſupplies them with vegetable and animal abundance.

The form of the face ſeems rather to be the reſult of cuſtom. Nations who have long conſidered ſome artificial deformity as beautiful, who have induſtriouſly leſſened the feet, or flattened the noſe, by degrees, begin to receive the impreſſion they are taught to aſſume; and Nature, in a courſe of ages, ſhapes itſelf to the conſtraint, and aſſumes hereditary deformity. We find nothing more common in births than for children to inherit ſometimes even the accidental deformities of their parents. We have many inſtances of ſquinting in the father, which he received from fright, or habit, communicated to the offspring; and I myſelf have ſeen a child diſtinctly marked with a ſcar, ſimilar to one the father had received in battle. In this manner accidental deformities may become natural ones; and by aſſiduity may be continued, and even increaſed, through ſucceſſive generations. From this, therefore, may have ariſen the ſmall eyes and long ears of the Tartars, and Chineſe nations. From hence originally may have come the flat noſes of the blacks, and the flat heads of the American Indians.

In this ſlight ſurvey, therefore, I think we may ſee that all the variations in the human figure, as far as they differ from our own, are produced either by the rigour of the climate, the bad quality, or the ſcantineſs of the proviſions, or by the ſavage cuſtoms of the country. They are actual marks of the degeneracy in the human form; and we may conſider the European figure and colour as ſtandards to which to refer all other varieties, and with which to compare them. In proportion as the Tartar or American approaches nearer to European beauty, we conſider the race as leſs degenerated; in proportion as he differs more widely, he has made greater deviations from his original form.

That we have all ſprung from one common parent, we are taught, both by reaſon and religion, to believe; and we have good reaſon alſo to think that the Europeans reſemble him more than any of the reſt of his children. However, it muſt not be concealed that the olive-coloured Aſiatic, and even the jet-black Negroe, claim this honour of hereditary reſemblance; and aſſert that white men are mere deviations from original perfection. Odd as this opinion may ſeem, they have Linnæus, the celebrated naturaliſt, on their ſide; who ſuppoſes man a native of the tropical climates, and only a ſojourner more to the north. But, not to enter into a controverſy upon a matter of a very remote ſpeculation, I think one argument alone will ſuffice to prove the contrary, and ſhew that the white man is the original ſource from whence the other varieties have ſprung. We have frequently ſeen white children produced from black parents, but have never ſeen a black offspring the production of two whites. From hence we may conclude, that whiteneſs is the colour to which mankind naturally tends; for, as in the tulip, the parent ſtock is known by all the artificial varieties breaking into it; ſo in man, that colour muſt be original which never alters, and to which all the reſt are accidentally ſeen to change. I have ſeen in London, at different times, two white Negroes, the iſſue of black parents, that ſerved to convince me of the truth of this theory. I had before been taught to believe that the whiteneſs of the Negro ſkin was a diſeaſe, a kind of milky whiteneſs, that might be called rather a leperous cruſt than a natural complexion. I was taught to ſuppoſe that the numberleſs white Negroes, found in various parts of Africa, the white men that go by the name of Chacrelas, in the Eaſt Indies, and the white Americans, near the Iſthmus of Darien, in the Weſt Indies, were all as ſo many diſeaſed perſons, and even more deformed than the blackeſt of the natives. But, upon examining that Negro which was laſt ſhewn in London, I found the colour to be exactly like that of an European; the viſage white and ruddy, and the lips of the proper redneſs. However, there were ſufficient marks to convince me of its deſcent. The hair was white and woolly, and very unlike any thing I had ſeen before. The iris of the eye was yellow, inclining to red; the noſe was flat, exactly reſembling that of a Negro; and the lips thick and prominent. No doubt, therefore, remained of the child's having been born of Negro parents; and the perſon who ſhewed it had atteſtations to convince the moſt incredulous. From this then we ſee that the variations of the Negro colour is into whiteneſs, whereas the white are never found to have a race of Negro children. Upon the whole, therefore, all thoſe changes which the African, the Aſiatic, or the American undergo, are but accidental deformities, which a kinder climate, better nouriſhment, or more civilized manners, would, in a courſe of centuries, very probably remove.

CHAP. XII.

OF MONSTERS.

HITHERTO I have only ſpoken of thoſe varieties in the human ſpecies, that are common to whole nations; but there are varieties of another kind, which are only found in the individual; and being more rarely ſeen, are, therefore, called *monſtrous*. If we examine into the varieties of diſtorted Nature, there is ſcarce a limb of the body, or a feature in the face, that has not ſuffered ſome reprobation, either from Art or Nature; being enlarged or diminiſhed, lengthened or wreſted, from its due proportion. Linnæus, after having given a catalogue of monſters, particularly adds, the flat heads of Canada, the long heads of the Chineſe, and the ſlender waiſts of the women of Europe, who, by ſtrait lacing, take ſuch pains to deſtroy the health, through a miſtaken deſire to improve their beauty[*]. It belongs more to the phyſician than the naturaliſt to attend to theſe minute deformities; and, indeed, it is a melancholy contemplation to ſpeculate upon a catalogue of calamities, inflicted by unpitying Nature, or brought upon us by our own caprice. Some, however, are fond of ſuch accounts; and there have been books filled with nothing elſe. To theſe, therefore, I refer the reader; who may be better pleaſed with accounts of men with two heads, or without any head, of children joined in the middle, of bones turned into fleſh, or fleſh converted into bones than I am[†]. It is ſufficient here to obſerve, that every day's experience muſt have ſhewn us miſerable inſtances of this kind produced by Nature or Affection; calamities that no pity can ſoften, or aſſiduity relieve.

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[*] Linnæi Syſt. vol. i. p. 29. Monorchides ut minus fertiles.

[†] Vide Phil. Tranſ. paſſim. Miſcellan. Curioſſ. Johan. Baptiſt. Wenck. Diſſertatio Phyſica an ex virilis humani ſeminis cum brutali per nefarium co-

Paſſing over, therefore, every other account, I ſhall only mention the famous inſtance, quoted by Father Malbranche, upon which he founds his beautiful theory of monſtrous productions. A woman of Paris, the wife of a tradeſman, went to ſee a criminal broke alive upon the wheel, at the place of public execution. She was at that time two months advanced in her pregnancy, and no way ſubject to any diſorders to affect the child in her womb. She was, however, of a tender habit of body; and, though led by curioſity to this horrid ſpectacle, very eaſily moved to pity and compaſſion. She felt, therefore, all thoſe ſtrong emotions which ſo terrible a ſight muſt naturally inſpire; ſhuddered at every blow the criminal received, and almoſt ſwooned at his cries. Upon returning from this ſcene of blood, ſhe continued for ſome days penſive, and her imagination ſtill wrought upon the ſpectacle ſhe had lately ſeen. After ſome time, however, ſhe ſeemed perfectly recovered from her fright, and had almoſt forgotten her former uneaſineſs. When the time of her delivery approached, ſhe ſeemed no ways mindful of her former terrors, nor were her pains in labour more than uſual in ſuch circumſtances. But what was the amazement of her friends and aſſiſtants when the child came into the world! It was found that every limb in its body was broken like thoſe of the malefactor, and juſt in the ſame place. This poor infant, that had ſuffered the pains of life, even before its coming into the world, did not die, but lived in an hoſpital in Paris, for twenty years after, a wretched inſtance of the ſuppoſed powers of imagination in the mother, of altering and

itum commixtione, aut viciſſim ex bruti maris cum muliebri humano ſeminis commixtione poſſit verus homo generari. Vide etiam, Johnſtoni Thaumatographia Naturalis. Vide Adalberti Diſquſitio Phyſica oſtenti duorum puerorum unus quorum dente aureo, alter cum capite giganteo Biluæ ſpectabantur. A man without lungs and ſtomach, Journal de Scavans 1682, p. 301; another without any brain. Andreas Caroli Memorabilia, p. 167. an. 1676; another without any head. Giornale di Roma, anno 1675, p. 26; another without any arms. New Memoirs of Literature, vol. iv. p. 446. In ſhort, the variety of theſe accounts is almoſt infinite; and, perhaps, their uſe is as much circumſcribed as their variety is extenſive.

diſtorting the infant in the womb. The manner in which Malbranche reaſons upon this fact, is as follows: The Creator has eſtabliſhed ſuch a ſympathy between the ſeveral parts of Nature, that we are led not only to imitate each other, but alſo to partake in the ſame affections and deſires. The animal ſpirits are thus carried to the reſpective parts of the body, to perform the ſame actions which we ſee others perform, to receive in ſome meaſure their wounds, and take part in their ſufferings. Experience tells us, that if we look attentively on any perſon, ſeverely beaten, or ſorely wounded, the ſpirits immediately flow into thoſe parts of the body, which correſpond to thoſe we ſee in pain. The more delicate the conſtitution, the more it is thus affected; the ſpirits making a ſtronger impreſſion on the fibres of a weakly habit than of a robuſt one. Strong vigorous men ſee an execution without much concern, while women of nicer texture are ſtruck with horror and concern. This ſenſibility in them muſt, of conſequence, be communicated to all parts of their body; and, as the fibres of the child, in the womb, are incomparably finer than thoſe of the mother, the courſe of the animal ſpirits muſt conſequently produce greater alterations. Hence, every ſtroke given to the criminal, forcibly ſtruck the imagination of the woman; and, by a kind of counter ſtroke, the delicate tender frame of the child.

Such is the reaſoning of an ingenious man upon a fact, the veracity of which many ſince have called in queſtion*. They have allowed, indeed, that ſuch a child might have been produced, but have denied the cauſe of its deformity.— "How could the imagination of the mother," ſay they, "produce ſuch dreadful effects upon her child? She has no communication with the infant; ſhe ſcarce touches it in any part; quite unaffected with her concerns, it ſleeps in ſecurity, in a manner ſecluded by a fluid in which it ſwims, from her that bears it. With what a variety of deformities," ſay they, "would all mankind be marked, if all the vain and capricious deſires of the mother were thus readily written upon the body of the child?" Yet, notwithſtanding this plauſible way of reaſoning, I cannot avoid giving ſome credit to the variety of inſtances I have either read, or ſeen, upon this ſubject. If it be a prejudice, it is as old as the days of Ariſtotle, and, to this day, as ſtrongly believed by the generality of mankind as ever. It does not admit of a reaſon; and, indeed, I can give none, even why the child ſhould, in any reſpect, reſemble the father or the mother. The fact we generally find to be ſo. But why it ſhould take the particular print of the father's features in the womb, it is as hard to conceive, as why it ſhould be affected by the mother's imagination. We all know what a ſtrong effect the imagination has on thoſe parts in particular, without being able to aſſign a cauſe how this effect is produced; and why the imagination may not produce the ſame effect in marking the child that it does in forming it, I ſee no reaſon. Thoſe perſons whoſe employment it is to rear up pigeons of different colours, can breed them, as their expreſſion is, to a feather. In fact, by properly pairing them, they can give what colour they will to any feather, in any part of the body. Were we to reaſon upon this fact, what could we ſay? Might it not be aſſerted, that the egg, being diſtinct from the body of the female, cannot be influenced by it? Might it not be plauſibly ſaid, that there is no ſimilitude between any part of the egg and any particular feather, which we expect to propagate? and yet, for all this, the fact is known to be true, and what no ſpeculation can invalidate. In the ſame manner, a thouſand various inſtances aſſure us that the child in the womb is ſometimes marked by the ſtrong affections of the mother; how this is performed we know not; we only ſee the effect, without any connexion between it and the cauſe. The beſt phyſicians have allowed it; and have been ſatisfied to ſubmit to the experience of a number of ages; but many diſbelieve it, becauſe they expect a reaſon for every effect.— This, however, is very hard to be given, while it is very eaſy to appear wiſe by pretending incredulity.

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* Buffon vol. iv. p. 9.

Among the number of monſters, dwarfs and giants are uſually reckoned; though not, perhaps, with the ſtricteſt propriety, ſince they are no way different from the reſt of mankind, except in ſtature. It is a diſpute, however, about words; and, therefore, ſcarce worth contending about. But there is a diſpute, of a more curious nature, on this ſubject; namely, whether there are races of people thus very diminutive, or vaſtly large, or whether they be merely accidental varieties, that now and then are ſeen in the country, in a few perſons, whoſe bodies ſome external cauſe has contributed to leſſen or enlarge.

With regard to men of diminutive ſtature, all Antiquity has been unanimous in aſſerting their national exiſtence. Homer was the firſt who has given us an account of the pigmy nation contending with the cranes; and what poetical licence might be ſuppoſed to exaggerate, Athenæus has attempted ſeriouſly to confirm by hiſtorical aſſertion*. If we attend to theſe, we muſt believe that in the internal parts of Africa, there are whole nations of pigmy beings, not more than a foot in ſtature, who continually wage an unequal war with the birds and beaſts that inhabit the plains in which they reſide. Some of the ancients, however, and Strabo in particular, have ſuppoſed all theſe accounts to be fabulous; and have been more inclined to think this ſuppoſed nation of pigmies, nothing more than a ſpecies of apes, well known to be numerous in that part of the world. With this opinion the moderns have all concurred; and that diminutive race, which was deſcribed as human, has been long degraded into a claſs of animals that reſemble us but very imperfectly.

The exiſtence, therefore, of a pigmy race of mankind, being founded in error, or in fable, we can expect to find men of diminutive ſtature only by accident, among men of the ordinary ſize. Of theſe accidental dwarfs, every country, and almoſt every village, can produce numerous inſtances. There was a time when theſe unfavoured children of Nature were the peculiar favourites of the great; and no prince or nobleman thought himſelf completely attended, unleſs he had a dwarf among the number of his domeſtics. Theſe poor little men were kept to be laughed at; or to raiſe the barbarous pleaſure of their maſters, by their contraſted inferiority. Even in England, as late as the times of King James I. the court was at one time furniſhed with a dwarf, a giant, and a jeſter: theſe the king often took a pleaſure in oppoſing to each other, and often fomented quarrels among them, in order to be a concealed ſpectator of their animoſity. It was a particular entertainment of the courtiers at that time, to ſee little Jeffery, for ſo the dwarf was called, ride round the liſts, expecting his antagoniſt; and diſcovering, in his actions, all the marks of contemptible reſolution.

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* Athenæus ix. 390.

It was in the ſame ſpirit, that Peter of Ruſſia, in the year 1710, celebrated a marriage of dwarfs. This monarch, tho' raiſed by his native genius far above a barbarian, was, nevertheleſs, ſtill many degrees removed from actual refinement. His pleaſures, therefore, were of the vulgar kind; and this was among the number. Upon a certain day, which he had ordered to be proclaimed ſeveral months before, he invited the whole body of his courtiers, and all the foreign ambaſſadors, to be preſent at the marriage of a pigmy man and woman. The preparations for this wedding were not only very grand, but executed in a ſtyle of barbarous ridicule. He ordered that all the dwarf men and women, within two hundred miles, ſhould repair to the capital; and alſo inſiſted, that they ſhould be preſent at the ceremony. For this purpoſe, he ſupplied them with proper vehicles; but ſo contrived it, that one horſe was ſeen carrying in a dozen of them into the city at once, while the mob followed, ſhouting and laughing, from behind. Some of them were at firſt unwilling to obey an order, which they knew was calculated to turn them into ridicule, and did not come; but he ſoon obliged them to obey; and, as a puniſhment, enjoined, that they ſhould wait upon the reſt at dinner. The whole company of dwarfs amounted to ſeventy, beſide the bride and bridegroom, who were richly adorned, and in the extremity of the faſhion. For this little company in miniature, every thing was ſuitably provided; a low table, ſmall plates, little glaſſes, and, in ſhort, every thing was ſo fitted, as if all things had been dwindled to their own ſtandard. It was his great pleaſure to ſee their gravity and their pride; the contention of the women for places, and the men for ſuperiority. This point he attempted to adjuſt, by ordering that the moſt diminutive ſhould take the lead; but this bred diſputes, for none would then conſent to ſit foremoſt. All this, however, being at laſt ſettled, dancing followed the dinner, and the ball was opened with a minuet by the bridegroom, who meaſured exactly three feet two inches high. In the end, matters were ſo contrived, that this little company, who met together in gloomy pride, and unwilling to be pleaſed, being at laſt familiarized to laughter, joined in the diverſion, and became, as the journaliſt has it*, extremely ſprightly and entertaining.

But whatever may be the entertainment ſuch gueſts might afford when united, I never found a drawf capable of affording any when alone. I have ſometimes converſed with ſome of theſe that were exhibited at our fairs about town, and have ever found their intellects as contracted as their perſons. They, in general, ſeemed to me to have faculties very much reſembling thoſe of children, and their deſires likewiſe of the ſame kind; being diverted with the ſame ſports, and beſt pleaſed with ſuch companions. Of all thoſe I have ſeen, which may amount to five or ſix, the little man, whoſe name was Coan, that died lately at Chelſea, was the moſt intelligent and ſprightly. I have heard him and the giant, who ſung at the theatres, ſuſtain a very ridiculous duet, to which they were taught to give great ſpirit. But this mirth, and ſeeming ſagacity, were but aſſumed. He had, by long habit, been taught to look cheerful upon the approach of company; and his converſation was but the mere etiquette of a perſon that had been uſed to receive viſitors. When driven out of his walk, nothing could be more ſtupid or ignorant, nothing more dejected or forlorn. But we have a complete hiſtory of a dwarf, very accurately related by Mr. Daubenton, in his part of the Hiſtoire Naturelle; which I will here take leave to tranſlate.

This dwarf, whoſe name was Baby, was well known, having ſpent the greateſt part of his life at Lunenville, in the palace of Staniſlaus, the titular king of Poland. He was born in the village of Plaiſne, in France, in the year, 1741. His father and mother were peaſants, both of good conſtitutions, and inured to a life of huſbandry and labour. Baby, when born, weighed but a pound and a quarter. We are not informed of the dimenſions of his body at that time; but we may conjecture they were very ſmall, as he was preſented on a plate to be baptized, and for a long time lay in a ſlipper. His mouth, although proportioned to the reſt of his body, was not, at that time, large enough to take in the nipple; and he was, therefore, obliged to be ſuckled by a ſhe-goat that was in the houſe; and that ſerved as a nurſe, attending to his cries with a kind of maternal fondneſs. He began to articulate ſome words when eighteen months old; and at two years he was able to walk alone. He was then fitted with ſhoes that were about an inch and a half long. He was attacked with ſeveral acute diſorders; but the ſmall-pox was the only one which left any marks behind it. Until he was ſix years old, he eat no other food but pulſe, potatoes, and bacon. His father and mother were, from their poverty, incapable of affording him any better nouriſhment; and his education was little better than his food, being bred up among the ruſtics of the place. At ſix years old he was about fifteen inches high; and his whole body weighed but thirteen pounds. Notwithſtanding this, he was well proportioned, and handſome; his health was good, but his underſtanding ſcarce paſſed the bounds of inſtinct. It was at that time that the king of Poland, having heard of ſuch a curioſity, had him conveyed to Lunenville, gave him the name of *Baby*, and kept him in his palace.

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* Die dench wurdidge. Iwerg. Hockweit, &c. Lipſiæ, 1713, vol. viii, page 102, ſeq.

Baby, having thus quitted the hard condition of a peaſant to enjoy all the comforts and the conveniences of life, ſeemed to receive no alteration from his new way of living, either in mind or in perſon. He preſerved the goodneſs of his conſtitution till about the age of ſixteen, but his body ſeemed to increaſe very ſlowly during the whole time; and his ſtupidity was ſuch, that all inſtructions were loſt in improving his underſtanding. He could never be brought to have any ſenſe of religion, nor even to ſhew the leaſt ſigns of a reaſoning faculty. They attempted to teach him dancing and muſic, but in vain; he never could make any thing of muſic; and as for dancing, although he beat time tolerably exact, yet he could never remember the figure, but while his dancing-maſter ſtood by to direct his motions. Notwithſtanding a mind thus deſtitute of underſtanding, was not without its paſſions, anger and jealouſy haraſſed it at times; nor was he without deſires of another nature.

At the age of ſixteen, Baby was twenty-nine inches tall; at this he reſted; but having thus arrived at his acme, the alterations of puberty, or rather, perhaps, of old age, came faſt upon him. From being very beautiful, the poor little creature now became quite deformed; his ſtrength quite forſook him; his back-bone began to bend; his head hung forward; his legs grew weak; one of his ſhoulders turned awry; and his noſe grew diſproportionably large. With his ſtrength, his natural ſpirits alſo forſook him; and, by the time he was twenty, he was grown feeble, decrepid, and marked with the ſtrongeſt impreſſions of old age. It had been before remarked by ſome, that he would die of old age before he arrived at thirty; and, in fact, by the time he was twenty-two, he could ſcarcely walk a hundred paces, being worn with the multiplicity of his years, and bent under the burthen of protracted life. In this year he died; a cold, attended with a ſlight fever, threw him into a kind of lethargy, which had a few momentary intervals; but he could ſcarce be brought to ſpeak. However, it is aſſerted, that in the five laſt days of his life, he ſhewed a clearer underſtanding, than in his times of beſt health: but at length he died, after enduring great agonies, in the twenty-ſecond year of his age.

Oppoſite to this accidental diminution of the human race, is that of its extraordinary magnitude. Concerning the reality of a nation of Giants, there have been many diſputes among the learned. Some have affirmed the probability of ſuch a race; and others, as warmly have denied the poſſibility of their exiſtence. But it is not from any ſpeculative reaſonings, upon a ſubject of this kind, that information is to be obtained; it is not from the diſputes of the ſcholar, but the labours of the enterpriſing, that we are to be inſtructed in this inquiry. Indeed, nothing can be more abſurd, than what ſome learned men have advanced upon this ſubject. It is very unlikely, ſays Grew, that there ſhould either be dwarfs or giants; or if ſuch, they cannot be fitted for the uſual enjoyment of life and reaſon. Had man been born a dwarf, he could not have been a reaſonable creature; for to that end, he muſt have a jolt head, and then he would not have body and blood enough to ſupply his brain with ſpirits;

or if he had a ſmall head, proportionable to his body, there would not be brain enough for conducting life. But it is ſtill worſe with giants; and there could never have been a nation of ſuch, for there would not be food enough found in any country to ſuſtain them; or if there were beaſts ſufficient for this purpoſe, there would not be graſs enough for their maintenance. But what is ſtill more, add others, giants could never be able to ſupport the weight of their own bodies; ſince a man of ten feet high, muſt be eight times as heavy as one of the ordinary ſtature; whereas, he has but twice the ſize of muſcles to ſupport ſuch a burthen: and, conſequently, would be overloaded with the weight of his own body. Such are the theories upon this ſubject; and they require no other anſwer, but that experience proves them both to be falſe; dwarfs are found capable of life and reaſon; and giants are ſeen to carry their own bodies. We have ſeveral accounts from mariners, that a nation of giants actually exiſts; and mere ſpeculation ſhould never induce us to doubt their veracity.

Ferdinand Magellan was the firſt who diſcovered this race of people along the coaſt, towards the extremity of South America. Magellan was a Portugueſe, of noble extraction; who having long behaved with great bravery, under Albuquerque, the conqueror of India, he was treated with neglect by the court, upon his return. Applying, therefore, to the king of Spain, he was intruſted with the command of five ſhips, to ſubdue the Molucca iſlands; upon one of which he was ſlain. It was in his voyage thither, that he happened to winter in St. Julian's Bay, an American harbour, forty-nine degrees ſouth of the line. In this deſolate region, were nothing was ſeen but objects of terror, where neither trees nor verdure dreſt the face of the country, they remained for ſome months without ſeeing any human creature. They had judged the country to be utterly uninhabitable; when one day, they ſaw approaching, as if he had been dropt from the clouds, a man of enormous ſtature, dancing and ſinging, and putting duſt upon his head, as they ſuppoſed, in token of peace. This overture for friendſhip was, by Magellan's command, quickly anſwered by the reſt of his men; and the giant approaching, teſtified every mark of aſtoniſhment and ſurpriſe. He was ſo tall, that the Spaniards only reached his waiſt; his face was broad, his colour brown, and painted over with a variety of tints; each cheek had the reſemblance of an heart drawn upon it; his hair was approaching to whiteneſs; he was clothed in ſkins, and armed with a bow. Being treated with kindneſs, and diſmiſſed with ſome trifling preſents, he ſoon returned with many more of the ſame ſtature; two of whom the mariners decoyed on ſhip-board: nothing could be more gentle than they were in the beginning; they conſidered the fetters that were preparing for them as ornaments, and played with them, like children with their toys; but when they found for what purpoſe they were intended, they inſtantly exerted their amazing ſtrength, and broke them in pieces with a very eaſy effort. This account, with a variety of other circumſtances, has been confirmed by ſucceeding travellers: Herrera, Sebald Wert, Oliver Van Noort, and James le Maire, all correſpond in affirming the fact, although they differ in many particulars of their reſpective deſcriptions. The laſt voyager we have had, that has ſeen this enormous race, is Commodore Byron. I have talked with the perſon who firſt gave the relation of that voyage, and who was the carpenter of the Commodore's ſhip; he was a ſenſible, underſtanding man, and I believe extremely faithful. By him, therefore, I was aſſured, in the moſt ſolemn manner, of the truth of his relation; and this account has ſince been confirmed by one or two publications; in all which the particulars are pretty nearly the ſame. One of the circumſtances which moſt puzzled me to reconcile to probability, was that of the horſes, on which they are deſcribed as riding down to the ſhore. We know the American horſe to be of European breed; and, in ſome meaſure, to be degenerated from the original. I was at a loſs, therefore, to account how a horſe of not more than fourteen hands high, was capable of carrying a man of nine feet; or, in other words, an animal almoſt as large as itſelf. But the wonder will ceaſe, when we conſider, that ſo ſmall a beaſt as an aſs, will carry a man of ordinary ſize tolerably well; and in proportion between this, and the former inſtance, is nearly exact. We can no longer, therefore, refuſe our aſſent to the exiſtence of this gigantic race of mankind; in what manner they are propagated, or under what regulations they live, is a ſubject that remains for future inveſtigation. It ſhould appear, however, that they are a wandering nation, changing their abode with the courſe of the ſun, and ſhifting their ſituation, for the convenience of food, climate, or paſture*.

This race of giants are deſcribed as poſſeſſed of great ſtrength; and, no doubt, they muſt be very different from thoſe accidental giants that are to be ſeen in different parts of Europe. Stature with theſe, ſeems rather their infirmity than their pride; and adds to their burthen, without increaſing their ſtrength. Of thoſe I have ſeen, the generality were ill-formed and unhealthful; weak in their perſons, or incapable of exerting what ſtrength they were poſſeſſed of. The ſame defects of underſtanding that attended thoſe of ſuppreſſed ſtature, were found in thoſe who were thus overgrown: they were heavy, phlegmatic, ſtupid, and inclined to ſadneſs. Their numbers, however, are but few; and it is thus kindly ordered by Providence, that as the middle ſtate is the beſt fitted for happineſs, ſo the middle ranks of mankind are produced in the greateſt variety.

However, mankind ſeems naturally to have a reſpect for men of extraordinary ſtature; and it has been a ſuppoſition of long ſtanding, that our anceſtors were much taller, as well as much more beautiful than we. This has been, indeed, a theme of poetical declamation from the beginning; and man was ſcarce formed, when he began to deplore an imaginary decay. Nothing is more natural than this progreſs of the mind, in looking up to antiquity with reverential wonder. Having been accuſtomed to compare the wiſdom of our fathers, with our own in early imbecility, the impreſſion of their ſuperiority remains when they no longer exiſt, and when we ceaſe to be inferior. Thus the men of every age conſider the paſt as wiſer than the preſent; and the reverence ſeems to accumulate as our imaginations aſcend. For this reaſon, we allow remote antiquity many advantages, without diſputing their title: the inhabitants of uncivilized countries repreſent them as taller and ſtronger; and the people of a more poliſhed nation, as more healthy and more wiſe.

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* Later voyagers have not confirmed this account, in ſome particulars.

Nevertheleſs, theſe attributes ſeem to be only the prejudices of ingenuous minds; a kind of gratitude, which we hope in turn to receive from poſterity. The ordinary ſtature of men, Mr. Derham obſerves, is in all probability, the ſame now as at the beginning. The oldeſt meaſure we have of the human figure, is in the monument of Cheops, in the firſt pyramid of Egypt. This muſt have ſubſiſted many hundred years before the time of Homer, who is the firſt that deplores the decay. This monument, however, ſcarce exceeds the meaſure of our ordinary coffins: the cavity is no more than ſix feet long, two feet wide, and deep in about the ſame proportion. Several mummies alſo, of a very early age, are found to be only of the ordinary ſtature; and ſhew that, for theſe three thouſand years at leaſt, men have not ſuffered the leaſt diminution. We have many corroborating proofs of this, in the ancient pieces of armour which are dug up in different parts of Europe. The braſs helmet dug up at Medauro, fits one of our men, and yet is allowed to have been left there at the overthrow of Aſdrubal. Some of our fineſt antique ſtatutes, which we learn from Pliny, and others, to be exactly as big as the life, ſtill continue to this day, remaining monuments of the ſuperior excellence of their workmen indeed, but not of the ſuperiority of their ſtature. We may conclude, therefore, that men have been, in all ages, pretty much of the ſame ſize they are at preſent; and that the only difference muſt have been accidental, or perhaps national.

As to the ſuperior beauty of our anceſtors, it is not eaſy to make the compariſon; beauty ſeems a very uncertain charm; and frequently is leſs in the object, than in the eye of the beholder. Were a modern lady's face formed exactly like the Venus of Medicis, or the Sleeping Veſtal, ſhe would ſcarce be conſidered beautiful, except by the lovers of antiquity, whom, of all her admirers, perhaps, ſhe would be leaſt deſirous of pleaſing. It is true, that we have ſome diſorders among us that disfigure the features, and from which the ancients were exempt; but it is equally true, that we want ſome which were common among them, and which were equally deforming. As for their intellectual powers, theſe alſo were probably the ſame as ours: we excel them in the ſciences, which may be conſidered as an hiſtory of accumulated experience; and they excel us in the poetic arts, as they had the firſt rifling of all the ſtriking images of Nature.

CHAP. XIII.

OF MUMMIES, WAX-WORKS, &C.

"MAN* is not content with the uſual term of life, but he is willing to lengthen out his exiſtence by art; and although he cannot prevent death, he tries to obviate his diſſolution. It is natural to attempt to preſerve even the moſt trifling relicks of what has long given us pleaſure; nor does the mind ſeparate from the body, without a wiſh, that even the wretched heap of duſt it leaves behind, may yet be remembered. The embalming, practiſed in various nations, probably had its riſe in this fond deſire: an urn filled with aſhes, among the Romans, ſerved as a pledge of continuing affection; and even the graſſy graves in our own church-yards, are raiſed above the ſurface, with the deſire that the body below ſhould not be wholly forgotten. The ſoul, ardent after eternity for itſelf, is willing to procure, even for the body, a prolonged duration."

But of all nations, the Egyptians carried this art to the higheſt perfection: as it was a principle of their religion, to ſuppoſe the ſoul continued only coeval to the duration of the body, they tried every art to extend the life of the one, by preventing the diſſolution of the other. In this practice they were exerciſed from the earlieſt ages; and the mummies they have embalmed in this manner, continue in great numbers to the preſent day. We are told, in Geneſis, that Joſeph ſeeing his father expire, gave orders to his phyſicians to embalm the body, which they executed in the compaſs of forty days, the uſual time of embalming. Herodotus alſo, the moſt ancient of the profane hiſtorians, gives us a copious detail of this art, as it was practiſed, in his time, among the Egyptians. There are certain men among them, ſays he, who practiſe embalming as a trade; which they perform with all expedition poſſible. In the firſt place, they draw out the brain through the noſtrils, with irons adapted to this purpoſe; and in proportion as they evacuate it in this manner, they fill up the cavity with aromatics: they next cut open the belly, near the ſides, with a ſharpened ſtone, and take out the entrails, which they cleanſe, and waſh in palm oil: having performed this operation, they roll them in aromatic powder, fill them with myrrh, caſſia, and other perfumes, except incenſe; and replace them, ſewing up the body again. After theſe precautions, they ſalt the body with nitre, and keep it in the ſalting-place for ſeventy days, it not being permitted to preſerve it ſo any longer. When the ſeventy days are accompliſhed, and the body waſhed once more, they ſwathe it in bands made of linen, which have been dipt in a gum the Egyptians uſe inſtead of ſalt. When the friends have taken back the body, they make an hollow trough, ſomething like the ſhape of a man, in which they place the body; and this they incloſe in a box, preſerving the whole as a moſt precious relick, placed againſt the wall. Such are the ceremonies uſed with regard to the rich; as for thoſe who are contented with a humbler preparation, they treat them as follows: they fill a ſyringe with an odoriferous liquor extracted from the cedar-tree, and, without making an inciſion, inject it up the body of the deceaſed, and then keep it in nitre, as long as in the former caſe. When the time is expired, they evacuate the body of the cedar liquor which had been injected; and ſuch is the effect of this operation, that the liquor diſſolves the inteſtines and brings them away: the nitre alſo ſerves to eat away the fleſh; and leaves only the ſkin and the bones remaining. This done, the body is returned to the friends, and the embalmer takes no farther trouble about it. The third method of embalming thoſe of the meaneſt condition, is merely by purging and cleanſing the inteſtines by frequent injections, and preſerving the body for a ſimilar term in nitre, at the end of which it is reſtored to the relations.

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* This chapter I have, in a great meaſure, tranſlated from Mr. Daubenton. Whatever is added from others, is marked with inverted commas.

Diodorus Siculus, alſo, makes mention of the manner in which theſe embalmings are performed. According to him, there were ſeveral officers appointed for this purpoſe: the firſt of them, who was called the ſcribe, marked thoſe parts of the body, on the left ſide, which were to be opened; the cutter made the inciſion; and one of thoſe that were to ſalt it, drew out all the bowels, except the heart and the kidneys; another waſhed them in palm-wine and odoriferous liquors; afterwards, they anointed for above thirty days, with cedar, gum, myrrh, cinnamon, and other perfumes. Theſe aromatics preſerved the body entire for a long time, and gave it a very agreeable odour. It was not in the leaſt disfigured by this preparation; after which it was returned to the relations, who kept it in a coffin, placed upright againſt the wall.

Moſt of the modern writers who have treated on this ſubject, have merely repeated what has been ſaid by Herodotus; and if they add any thing of their own, it is but merely from conjecture. Dumont obſerves, that it is very probable, that aloes, bitumen, and cinnamon, make a principal part of the compoſition which is uſed on this occaſion: he adds, that, after embalming, the body is put into a coffin, made of the ſycamore-tree, which is almoſt incorruptible. Mr. Grew remarks, that in an Egyptian mummy, in the poſſeſſion of the Royal Society, the preparation was ſo penetrating, as to enter into the very ſubſtance of the bones, and rendered them ſo black, that they ſeemed to have been burnt. From this, he is induced to believe, that the Egyptians had a cuſtom of embalming their dead, by boiling them in a kind of liquid preparation, until all the aqueous parts of the body were exhaled away; and until the oily or gummy matter had penetrated throughout. He propoſes, in conſequence of this, a method of macerating, and afterwards of boiling the dead body in oil of walnut.

I am, for my own part, of opinion, that there were ſeveral ways of preſerving dead bodies from putrefaction; and that this would be no difficult matter, ſince different nations have all ſucceeded in the attempt. We have an example of this kind among the Guanches, the ancient inhabitants of the iſland of Teneriff. Thoſe who ſurvived the general deſtruction of this people by the Spaniards, when they conquered this iſland, informed them, that the art of embalming was ſtill preſerved there; and that there was a tribe of prieſts among them poſſeſſed of the ſecret, which they kept concealed as a ſacred myſtery. As the greateſt part of the nation was deſtroyed, the Spaniards could not arrive at a complete knowledge of this art; they only found out a few of the particulars. Having taken out the bowels, they waſhed the body ſeveral times in a lee, made of the dried bark of the pine-tree, warmed, during the ſummer, by the ſun, or by a ſtove in the winter. They afterwards anointed it with butter, or the fat of bears, which they had previouſly boiled with odoriferous herbs, ſuch as ſage and lavender. After this unction, they ſuffered the body to dry; and then repeated the operation as often as it was neceſſary, until the whole ſubſtance was impregnated with the preparation. When it was become very light, it was then a certain ſign it was fit and properly prepared. They then rolled it up in the dried ſkins of goats; which, when they had a mind to ſave expence, they ſuffered to remain with the hair ſtill growing upon them. Purchas aſſures us, that he has ſeen mummies of this kind in London; and mentions the name of a gentleman who had ſeen ſeveral of them in the iſland of Teneriff, which were ſuppoſed to have been two thouſand years old; but without any certain proofs of ſuch great antiquity. This people, who probably came firſt from the coaſts of Africa, might have learned this art from the Egyptians, as there was a traffic carried on from thence into the moſt internal parts of Africa.

Father Acoſta and Garcilaſſo de la Vega make no doubt but that the Peruvians underſtood the art of preſerving their dead for a very long ſpace of time. They aſſert their having ſeen the bodies of ſeveral incas, that were perfectly preſerved. They ſtill preſerved their hair and their eye-brows; but they had eyes made of gold, put in the places of thoſe taken out. They were clothed in their uſual habits, and ſeated in the manner of the Indians, their arms placed on their breaſts.—Garcilaſſo touched one of their fingers, and found it apparently as hard, as wood; and the whole body was not heavy enough to over-burthen a weak man, who ſhould attempt to carry it away. Acoſta preſumes, that theſe bodies were embalmed with bitumen, of which the Indians knew the properties. Garcilaſſo, however, is of a different opinion, as he ſaw nothing bituminous about them; but he confeſſes, that he did not examine them very particularly; and he regrets his not having inquired into the methods uſed for that purpoſe. He adds, that, being a Peruvian, his countrymen would not have ſcrupled to inform him of the ſecret, if they really had it ſtill among them.

Garcilaſſo, thus being ignorant of the ſecret, makes uſe of ſome inductions, to throw light upon the ſubject; he aſſerts, that the air is ſo dry and ſo cold at Cuſco, that fleſh dries there like wood, without corrupting: and he is of opinion, that they dried the body in ſnow, before they applied the bitumen: he adds, that in the time of the incas, they uſually dried the fleſh which was deſigned for the uſe of the army; and that, when they had loſt their humidity, they might be kept without ſalt, or any other preparation.

It is ſaid, that at Spitſbergen, which lies within the arctic circle, and, conſequently in the coldeſt climate, bodies never corrupt, nor ſuffer any apparent alteration, even though buried for thirty years: nothing corrupts or putrefies in that climate; the wood which has been employed in building thoſe houſes where the train-oil is ſeparated, appears as freſh as the day it was firſt cut.

If exceſſive cold, therefore, be thus capable of preſerving bodies from corruption, it is not leſs certain, that a great degree of dryneſs, produced by heat, produces the ſame effect. It is well known, that the men and animals that are buried in the ſands of Arabia, quickly dry up, and continue in preſervation for ſeveral ages, as if they had been actually embalmed. It has often happened, that whole caravans have periſhed in croſſing thoſe deſerts, either by the burning winds that infeſt them, or by the ſands which are raiſed by the tempeſt, and overwhelm every creature in certain ruin. The bodies of thoſe perſons are preſerved entire; and they are often found in this condition by ſome accidental paſſenger. Many authors, both ancient and modern, make mention of ſuch mummies as theſe; and Shaw ſays, that he has been aſſured, that numbers of men, as well as other animals, have been thus preſerved, for times immemorial, in the burning ſands of Saibah, which is a place, he ſuppoſes, ſituate between Raſem and Egypt.

The corruption of dead bodies being entirely cauſed by the fermentation of the humours, whatever is capable of hindering or retarding this fermentation, will contribute to their preſervation. Both heat and cold, though ſo contrary in themſelves, produce ſimilar effects in this particular, by drying up the humours. The cold in condenſing and thickening them, and the heat in evaporating them before they have time to act upon the ſolids. But it is neceſſary that theſe extremes ſhould be conſtant; for if they ſucceed each other ſo as that cold ſhall follow heat, or dryneſs humidity, it muſt then neceſſarily happen, that corruption muſt enſue.—However, in temperate climates, there are natural cauſes capable of preſerving dead bodies; among which we may reckon the qualities of the earth in which they are buried. If the earth be drying and aſtringent, it will imbibe the humidity of the body; and it may be probably for this reaſon, that the bodies buried in the monaſtery of the Cordeliers, at Thouloufe, do not putrefy, but dry in ſuch a manner that they may be lifted up by one arm.

The gums, reſins, and bitumens, with which dead bodies are embalmed, keep off the impreſſions which they would elſe receive from the alteration of the temparature of the air; and ſtill more, if a body thus prepared be placed in a dry or burning ſand, the moſt powerful means will be united for its preſervation. We are not to be ſurpriſed, therefore, at what we are told by Chardin, of the country of Choroſan, in Perſia. The bodies which have been previouſly embalmed, and buried in the ſands of that country, as he aſſures us, are found to petrify; or, in other words, to become extremely hard, and are preſerved for ſeveral ages. It is aſſerted, that ſome of them have continued for a thouſand years.

The Egyptians, as has been mentioned above, ſwathed the body with linen bands, and incloſed it in a coffin; however, it is probable that, with all theſe precautions, they would not have continued till now, if the tombs, or pits, in which they were placed, had not been dug in a dry chalky ſoil, which was not ſuſceptible of humidity; and which was, beſides, covered over with a dry ſand of ſeveral feet thickneſs.

The ſepulchres of the ancient Egyptians ſubſiſt to this day. Moſt travellers who have been in Egypt have deſcribed thoſe of ancient mummies, and have ſeen the mummies interred there. Theſe catacombs are within two leagues of the ruins of this city, nine leagues from Grand Cairo, and about two miles from the village of Zaccara. They extend from thence to the Pyramids of Pharaoh, which are about eight miles diſtant. Theſe ſepulchres lie in a field, covered with a fine running ſand, of a yellowiſh colour. The country is dry and hilly; the entrance of the tomb is choked up with ſand; there are many open, but ſeveral more that are ſtill concealed. The inhabitants of the neighbouring village have no other commerce, or method of ſubſiſting, but by ſeeking out mummies, and ſelling them to ſuch ſtrangers as happen to be at Grand Cairo. "This commerce, ſome years ago, was not only a very common, but a very gainful one. A complete mummy was often ſold for twenty pounds: but it muſt not be ſuppoſed that it was bought at ſuch a high price from a mere paſſion for antiquity; there were much more powerful motives for this traffic. Mummy, at that time, made a conſiderable article in medicine; and a thouſand imaginary virtues were aſcribed to it, for the cure of moſt diſorders, particularly of the paralytic kind. There was no ſhop, therefore, without mummy in it; and no phyſician thought he had properly treated his patient, without adding this to his preſcription. Induced by the general repute, in which this ſuppoſed drug was at that time, ſeveral Jews, both of Italy and France, found out the art of imitating mummy ſo exactly, that they, for a long time, deceived all Europe. This they did by drying dead bodies in ovens, after having prepared them with myrrh, aloes, and bitumen. Still, however, the requeſt for mummies continued, and a variety of cures were daily aſcribed to them. At length, Paræus wrote a treatiſe on their total inefficacy in phyſic; and ſhewed their abuſe in loading the ſtomach, to the excluſion of more efficacious medicines. From that time, therefore, their reputation began to decline; the Jews diſcontinued their counterfeits, and the trade returned entire to the Egyptians, when it was no longer of value. The induſtry of ſeeking after mummies is now totally relaxed, their price merely arbitrary, and juſt what the curious are willing to give."

In ſeeking for mummies, they firſt clear away the ſand, which they may do for weeks together, without finding what is wanted. Upon coming to a little ſquare opening of about eighteen feet in depth, they deſcend into it, by holes for the feet, placed at proper intervals; and there they are ſure of finding what they ſeek for. Theſe caves, or wells, as they call them, are hollowed out of a white free-ſtone, which is found in all this country, a few feet below the covering of the ſand. When one gets to the bottom of theſe, which are ſometimes forty feet below the ſurface; there are ſeveral ſquare openings, on each ſide, into paſſages of ten or fifteen feet wide, and theſe lead to chambers of fifteen or twenty feet ſquare. Theſe are all hewn out of the rock; and, in each of the catacombs are to be found ſeveral of theſe apartments, communicating with each other. They extend a great way under ground, ſo as to be under the city of Memphis, and in a manner to undermine its environs.

In ſome of the chambers, the walls are adorned with figures and hieroglyphics; in others, the mummies are found in tombs, round the apartment hollowed out in the rock. Theſe tombs are upright, and cut into the ſhape of a man, with his arms ſtretched out. There are others found, and theſe in the greateſt number, in wooden coffins, or in clothes covered with bitumen. Theſe coffins, or wrappers, are covered all over with a variety of ornaments. There are ſome of them painted, and adorned with figures, ſuch as that of Death, and the leaden ſeals, on which ſeveral characters are engraven. Some of theſe coffins are carved into the human ſhape; but the head alone is diſtinguiſhable; the reſt of the body is all of a piece, and terminated by a pedeſtal, while there are ſome with their arms hanging down; and it is by theſe marks that the bodies of perſons of rank are diſtinguiſhed from thoſe of the meaner order. Theſe are generally found lying on the floor, without any profuſion of ornaments; and, in ſome chambers the mummies are found indiſcriminately piled upon each other, and buried in the ſand.

Many mummies are found lying on their backs; their heads turned to the north, and the hands placed on the belly. The bands of linen, with which theſe are ſwathed, are found to be more than a thouſand yards long; and, of conſequence, the number of circumvolutions they make about the body muſt have been amazing. Theſe were performed by beginning at the head, and ending at the feet; but they contrived it ſo as to avoid covering the face. However, when the face is entirely uncovered, it moulders into duſt immediately upon the admiſſion of the air. When, therefore, it is preſerved entire, a ſlight covering of cloth is ſo diſpoſed over it, as that the ſhape of the eyes, the noſe, and the mouth, are ſeen under it. Some mummies have been found with a long beard, and hair that reached down to the mid-leg, nails of a ſurpriſing length, and ſome gilt, or at leaſt painted of a gold colour. Some are found with bands upon the breaſt, covered with hieroglyphics, in gold, ſilver, or in green; and ſome with tutelary idols, and other figures of jaſper, within their body. A piece of gold, alſo, has often been found under their tongues, of about two piſtoles value; and, for this reaſon, the Arabians ſpoil all the mummies they meet with, in order to get at the gold.

But though art, or accident, has thus been found to preſerve dead bodies entire, it muſt by no means be ſuppoſed that it is capable of preſerving the exact form and lineaments of the deceaſed perſon. Thoſe bodies which are found dried away in the deſerts, or in ſome particular church-yards, are totally deformed, and ſcarce any lineaments remain of their external ſtructure. Nor are the mummies preſerved by embalming, in a better condition. The fleſh is dried away, hardened, and hidden under a variety of bandages; the bowels, as we have ſeen, are totally removed; and from hence, in the moſt perfect of them, we ſee only a ſhapeleſs maſs of ſkin diſcoloured; and even the features ſcarce diſtinguiſhable. The art is, therefore, an effort rather of preſerving the ſubſtance than the likeneſs of the deceaſed; and has, conſequently, not been brought to its higheſt pitch of perfection. It appears from a mummy, not long ſince dug up in France, that the art of embalming was more completely underſtood in the weſtern world than even in Egypt.

This mummy, which was dug up at Auvergne, was an amazing inſtance of their ſkill, and is one of the moſt curious relics in the art of preſervarion. As ſome peaſants, in that part of the world, were digging in a field near Rion, within about twenty-ſix paces of the highway, between that and the river Artier, they diſcovered a tomb, about a foot and a half beneath the ſurface. It was compoſed only of two ſtones; one of which formed the body of the ſepulchre, and the other the cover. This tomb was of freeſtone; ſeven feet and a half long, three feet and a half broad, and about three feet high. It was of rude workmanſhip; the cover had been poliſhed, but was without figure or inſcription: within this tomb was placed a leaden coffin, four feet ſeven inches long, fourteen inches broad, and fifteen high. It was not made coffin-faſhion, but oblong, like a box, equally broad at both ends, and covered with a lid that fitted on like a ſnuff-box, without a hinge. This cover had two holes in it, each of about two inches long, and very narrow, filled with a ſubſtance reſembling butter; but for what purpoſe intended remains unknown. Within this coffin was a mummy, in the higheſt and moſt perfect preſervation. The internal ſides of the coffin were filled with an aromatic ſubſtance, mingled with clay. Round the mummy was wrapped a coarſe cloth, in form of a napkin; under this were two ſhirts, or ſhrouds, of the moſt exquiſite texture; beneath theſe a bandage, which covered all parts of the body, like an infant in ſwaddling clothes; ſtill under this general bandage there was another, which went particularly round the extremities, the hands, and the legs. The head was covered with two caps; the feet and hands were without any particular bandages; and the whole body was covered with an aromatic ſubſtance, an inch thick. When theſe were removed, and the body expoſed naked to view, nothing could be more aſtoniſhing than the preſervation of the whole, and the exact reſemblance it bore to a body that had been dead a day or two before. It appeared well proportioned, except that the head was rather large, and the feet ſmall. The ſkin had all the pliancy and colour of a body lately dead; the viſage, however was of a browniſh hue. The belly yielded to the touch; all the joints were flexible, except thoſe of the legs and feet; the fingers ſtretched forth of themſelves when bent inwards. The nails ſtill continued entire; and all the marks of the joints, both in the fingers, the palms of the hands, and the ſoles of the feet, remained perfectly viſible. The bones of the arms and legs were ſoft and pliant; But, on the contrary, thoſe of the ſkull preſerved their rigidity; the hair, which only covered the back of the head, was of a long cheſnut colour, and about two inches long. The pericranium at top was ſeparated from the ſkull, by an inciſion, in order to open it for the introducing proper aromatics in the place of the brain, where they were found mixed with clay. The teeth, the tongue, and the ears, were all preſerved in perfect form. The inteſtines were not taken out of the body, but remained pliant and entire, as in a freſh ſubject; and the breaſt was made to riſe and fall like a pair of bellows. The embalming preparation had a very ſtrong and pungent ſmell, which the body preſerved for more than a month after it was expoſed to the air. This odour was perceived wherever the mummy was laid; although it remained there but a very ſhort time, it was even pretended that the peaſants of the neighbouring villages were incommoded by it. If one touched either the mummy, or any part of the preparation, the hands ſmelled of it for ſeveral hours after, although waſhed with water, ſpirit of wine, or vinegar. This mummy, having remained expoſed for ſome months to the curioſity of the public, began to ſuffer ſome mutilations. A part of the ſkin of the forehead was cut off; the teeth were drawn out, and ſome attempts were made to pull away the tongue. It was, therefore, put into a glaſs-caſe, and ſhortly after tranſmitted to the King of France's cabinet, at Paris.

There are many reaſons to believe this to be the body of a perſon of the higheſt diſtinction; however, no marks remain to aſſure us either of the quality of the perſon, or the time of his deceaſe. There only are to be ſeen ſome irregular figures on the coffin; one of which repreſents a kind of ſtar. There were alſo ſome ſingular characters upon the bandages, which were totally defaced by thoſe who had torn them away. However, it ſhould ſeem that it had remained for ſeveral ages in this ſtate, ſince the firſt years immediately ſucceeding the interment, are uſually thoſe in which the body is moſt liable to decay. It appears alſo to be a much more perfect method of embalming than that of the Egyptians; as in this the fleſh continues with its natural elaſticity and colour, the bowels remain entire, and the joints have almoſt the pliancy which they had when the perſon was alive. Upon the whole, it is probable that a much leſs tedious preparation than that uſed by the Egyptians would have ſufficed to keep the body from putrefaction; and that an injection of petreoleum inwardly, and a layer of aſphaltum, without, would have ſufficed to have made a mummy; and it is remarkable that Auvergne, where this was found, affords theſe two ſubſtances in ſufficient plenty. This art, therefore, might be brought to greater perfection than it has arrived at hitherto, were the art worth preſerving. But mankind have long ſince grown wiſer in this reſpect; and think it unneceſſary to keep by them a deformed carcaſs, which, inſtead of aiding their magnificence, muſt only ſerve to mortify their pride.

CHAP. XIV.

OF ANIMALS.

LEAVING man, we now deſcend to the lower ranks of Animated Nature, and prepare to examine the life, manners, and characters of theſe our humble partners in the creation. But, in ſuch a wonderful variety as is diffuſed around us, where ſhall we begin! The number of beings, endued with life, as well as we, ſeems, at firſt view, infinite. Not only the foreſt, the waters, the air, teems with animals of various kinds; but almoſt every vegetable, every leaf, has millions of minute inhabitants, each of which fill up the circle of its allotted life, and ſome of which are found objects of the greateſt curioſity. In this ſeeming exuberance of animals, it is natural for ignorance to lie down in hopeleſs uncertainty, and to declare what requires labour to particularize to be utterly inſcrutable. It is otherwiſe, however, with the active and ſearching mind; no way intimidated with the immenſe variety, it begins the taſk of numbering, grouping, and claſſing all the various kinds that fall within its notice; finds every day new relations between the ſeveral parts of the creation, acquires the art of conſidering ſeveral at a time under one point of view; and, at laſt, begins to find that the variety is neither ſo great nor ſo inſcrutable as was at firſt imagined. As in a clear night, the number of the ſtars ſeems infinite; yet, if we ſedulouſly attend to each in its place, and regularly claſs them, they will ſoon be found to diminiſh, and come within a very ſcanty computation.

Method, is one of the principal helps in natural hiſtory, and without it very little progreſs can be made in this ſcience. It is by that alone we can hope to diſſipate the glare, if I may ſo expreſs it, which ariſes from a multiplicity of objects at once preſenting themſelves to the view. It is method that fixes the attention to one point, and leads it, by ſlow and certain degrees, to leave no part of Nature unobſerved.

All naturaliſts, therefore, have been very careful in adopting ſome method of claſſing or grouping the ſeveral parts of Nature; and ſome have written books of natural hiſtory with no other view. Theſe methodical diviſions ſome have treated with contempt *, not conſidering that books, in general, are written with oppoſite views: ſome to be read, and ſome only to be occaſionally conſulted. The methodiſts, in natural hiſtory, ſeem to be content with the latter advantage; and have ſacrificed to order alone, all the delights of the ſubject, all the arts of heightening, awakening, or continuing curioſity. But they certainly have the ſame uſe in ſcience, that a dictionary has in language; but with this difference, that in a dictionary we proceed from the name to the definition; in a ſyſtem of natural hiſtory, we proceed from the definition to find out the thing. Without the aid of Syſtem, Nature muſt ſtill have lain undiſtinguiſhed, like furniture in a lumber-room; every thing we wiſh for is there, indeed; but we know not where to find it. If, for inſtance,

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* Mr. Buffon in his Introduction, &c.

in a morning excurſion, I find a plant, or an inſect, the name of which I deſire to learn; or, perhaps, am curious to know whether already known; in this inquiry I can expect information only from one of theſe ſyſtems, which, being couched in a methodical form, quickly directs me to what I ſeek for. Thus we will ſuppoſe that our inquirer has met with a ſpider, and that he has never ſeen ſuch an inſect before. He is taught by the writer of a ſyſtem* to examine whether it has wings, and he finds that it has none. He, therefore, is to look for it among the wingleſs inſects, or the Aptera, as Linnæus calls them; he then is to ſee whether the head and breaſt make one part of the body, or are diſunited: he finds they make one: he is then to reckon the number of feet and eyes, and he finds that it has eight of each. The inſect, therefore, muſt be either a ſcorpion or a ſpider, but he laſtly examines its feelers, which he finds clavated, or clubbed; and, by all theſe marks, he at laſt diſcovers it to be a ſpider. Of ſpiders, there are forty-ſeven ſorts; and, by reading the deſcription of each, the inquirer will learn the name of that which he deſires to know. With the name of the inſect, he is alſo directed to thoſe authors that have given any account of it, and the page where that account is to be found; by this means he may know at once what has been ſaid of that animal by others, and what there is of novelty in the reſult of his own reſearches.

From hence, it will appear how uſeful thoſe ſyſtems in natural hiſtory are to the inquirer; but, having given them all their merit, it would be wrong not to obſerve, that they have in general been very much abuſed. Their authors, in general, ſeem to think that they are improvers of natural hiſtory, when in reality they are but guides; they ſeem to boaſt that they are adding to our knowledge, while they are only arranging it. Theſe authors alſo, ſeem to think that the reading of their works and ſyſtems, is the beſt method to attain a knowledge of Nature; but, ſetting aſide the impoſſibility of getting through whole volumes of a dry long catalogue, the multiplicity of whoſe contents is too great for even the ſtrongeſt memory; ſuch works rather tell us the names than the hiſtory of the creature we deſire to inquire after. In theſe dreary pages, every inſect, or plant, that has a name, makes as diſtinguiſhed a figure as the moſt wonderful, or the moſt uſeful. The true end of ſtudying Nature is to make a juſt ſelection, to find thoſe parts of it that moſt conduce to our pleaſure or convenience, and to leave the reſt in neglect. But theſe ſyſtems, employing the ſame degree of attention upon all, give us no opportunities of knowing which moſt deſerves attention; and he who has made his knowledge from ſuch ſyſtems only, has his memory crowded with a number of trifling, or minute particulars, which it ſhould be his buſineſs and his labour to forget. Theſe books, as was ſaid before, are uſeful to be conſulted, but they are very unneceſſary to be read; no inquirer in Nature ſhould be without one of them; and, without any doubt, Linnæus deſerves the preference.

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* Linnæus.

One fault more, in almoſt all theſe ſyſtematic writers, and that which leads me to the ſubject of the preſent chapter, is, that ſeeing the neceſſity of methodical diſtribution in ſome parts of Nature, they have introduced it into all. Finding the utility of arranging plants, birds, or inſects, they have arranged quadrupeds alſo with the ſame aſſiduity; and although the number of theſe is ſo few as not to exceed two hundred, they have darkened the ſubject with diſtinctions and diviſions, which only ſerve to puzzle and perplex. All method is only uſeful in giving perſpicuity, where the ſubject is either dark or copious: but with regard to quadrupeds, the number is but few; many of them we are well acquainted with by habit; and the reſt may very readily be known, without any method. In treating of ſuch, therefore, it would be uſeleſs to confound the reader with a multiplicity of diviſions; as quadrupeds are conſpicuous enough to obtain the ſecond rank in Nature, it become us to be acquainted with, at leaſt, the names of them all. However, as there are naturaliſts who have gained a name from the excellence of their methods, in claſſing theſe animals, ſome readers may deſire to have a knowledge of what has been laboriouſly invented for their inſtruction. I will juſt take leave, therefore, to mention the moſt applauded methods of claſſing animals, as adopted by Ray, Klein, and Linnæus; for it often happens, that the terms which have been long uſed in a ſcience, though frivolous, become, by preſcription, a part of the ſcience itſelf. ...

Ray, after Ariſtotle, divides all animals into two kinds; thoſe which have blood, and thoſe which are bloodleſs. In the laſt claſs, he places all the inſect tribes. The former he divides into ſuch as breathe through the lungs, and ſuch as breathe through gills: theſe laſt comprehend the fiſhes. In thoſe which breathe through the lungs, ſome have the heart compoſed of two ventricles, and ſome have it of one. Of the laſt are all animals of the cetaceous kind, all oviparous quadrupeds, and ſerpents. Of thoſe that have two ventricles, ſome are oviparous, which are the birds; and ſome viviparous, which are quadrupeds. The quadrupeds he divides into ſuch as have a hoof, and ſuch as are claw-footed. Thoſe with the hoof, he divides into ſuch as have it undivided, ſuch as have it cloven, and ſuch as have the hoof divided into more parts, as the rhinoceros, and hippopotamos. Animals with the cloven hoof, he divides into ſuch as chew the cud, ſuch as the cow, and the ſheep; and ſuch as are not ruminant, as the hog. He divides thoſe animals that chew the cud, into four kinds: the firſt have hollow horns, which they never ſhed, as the cow; the ſecond is of a leſs ſpecies, and is of the ſheep kind; the third is of the goat kind; and the laſt, which have ſolid horns, and ſhed them annually, are of the deer kind. Coming to the claw-footed animals, he finds ſome with large claws, reſembling the fingers of the human hand; and theſe he makes the ape kind. Of the others, ſome have the foot divided in two, and have a claw to each diviſion; theſe are the camel kind. The elephant makes a kind by itſelf, as its claws are covered over by a ſkin. The reſt of the numerous tribe of claw-footed animals he divides into two kinds; the analogous, or ſuch as reſemble each other; and the anomalous, which differ from the reſt. The analogous claw-footed animals, are of two kinds: they have more than two cutting teeth in each jaw, ſuch as the lion and the dog, which are carnivorous; or they have but two cutting teeth in each jaw; and theſe are chiefly fed upon vegetables. The carnivorous kinds are divided into the great and the little. The great carnivorous animals are divided into ſuch as have a ſhort ſnout, as the cat and the lion; and ſuch as have it long and pointed, as the dog and the wolf. The little claw-footed carnivorous animals, differ from the great, in having a proportionably ſmaller head, and a ſlender body, that fits them for creeping into holes, in purſuit of their prey, like worms; and they are therefore called the vermin kind.

We ſee, from this ſketch of diviſion and ſub-diviſion, how a ſubject, extremely delightful and amuſing in itſelf, may be darkened, and rendered diſguſting. But, notwithſtanding, Ray ſeems to be one of the moſt ſimple diſtributors; and his method is ſtill, and not without reaſon, adopted by many. Such as have been at the trouble to learn this method, will certainly find it uſeful; nor would we be thought, in the leaſt, to take from its merits; all we contend for is, that the ſame information may be obtained by a pleaſanter and an eaſier method.

It was the great ſucceſs of Ray's method, that ſoon after produced ſuch a variety of attempts in the ſame manner; but almoſt all leſs ſimple, and more obſcure. Mr. Klein's method is briefly as follows: he makes the power of changing place, the characteriſtic mark of animals in general; and he takes their diſtinctions from their aptitude and fitneſs for ſuch a change. Some change place by means of feet, or ſome ſimilar contrivance; others have wings and feet: ſome can change place only in water, and have only fins; ſome go upon earth, without any feet at all: ſome change place, by moving their ſhell; and ſome move only at a certain time of the year. Of ſuch, however, as do not move at all, he takes no notice. The quadrupeds that move chiefly by means of four feet upon land, he divides into two orders. The firſt are the hoofed kind; and the ſecond, the claw kind. Each of theſe orders is divided into four families. The firſt family of the hoof kind, and the ſingle hoofed, ſuch as the horſe, aſs, &c. The ſecond family are ſuch as have the hoof cloven into two parts, ſuch as the cow, &c. The third family have the hoof divided into three parts; and in this family is found only the rhinoceros. The fourth family have the hoof divided into five parts; and in this is only to be found the elephant. With reſpect to the clawed kind, the firſt family comprehends thoſe that have but two claws on each foot, as the camel; the ſecond family have three claws; the third, four; and the fourth, five. This method of taking the diſtinctions of animals from the organs of motion, is ingenious; but it is, at the ſame time, incomplete; and, beſides, the diviſions into which it muſt neceſſarily fall, is inadequate; ſince, for inſtance, in his family with two claws, their is but one animal; whereas, in his family with five claws, there are above a hundred.

Briſſon, who has laboured this ſubject with great accuracy, divides Animated Nature into nine claſſes: namely, quadrupeds; cetaceous animals, or thoſe of the whale kind; birds; reptiles, or thoſe of the ſerpent kind; cartilaginous fiſhes; ſpinous fiſhes; ſhelled animals; inſects; and worms. He divides the quadrupeds into eighteen orders; and takes their diſtinctions, from the number and form of their teeth.

But of all thoſe whoſe ſyſtems have been adopted and admired, Linnæus is the foremoſt; as, with a ſtudied brevity, his ſyſtem comprehends the greateſt variety, in the ſmalleſt ſpace.

According to him, the firſt diſtinction of animals is to be taken from their internal ſtructure. Some have the heart with two ventricles, and hot red blood; namely, quadrupeds and birds. The quadrupeds are viviparous, and the birds, oviparous.

Some have the heart with but one ventricle, and cold red blood; namely, amphibia and fiſhes. The amphibia are furniſhed with lungs; the fiſhes, with gills.

Some have the heart with one ventricle, and cold white ſerum; namely, inſects and worms: the inſects have feelers; and the worms, holders.

The diſtinctions of quadrupeds, or animals with paps, as he calls them, are taken from their teeth. He divides them into ſeven orders; to which he gives names that are not eaſy of tranſlation: Primates, or principals, with four cutting teeth in each jaw; Bruta, or brutes, with no cutting teeth; Feræ, or wild beaſts, with generally ſix cutting teeth in each jaw; Glires, or dormice, with two cutting teeth, both above and below; Pecora, or cattle, with many cutting teeth above, and none below; Belluæ, or beaſts, with the fore-teeth blunt; Cete, or thoſe of the whale kind, with cartilaginous teeth. I have but juſt ſketched out this ſyſtem, as being, in it own nature, the cloſeſt abridgment; it would takes volumes to dilate it to its proper length. The names of the different animals, and their claſſes, alone makes two thick octavo volumes; and yet nothing is given but the ſlighteſt deſcription of each. I have omitted all criticiſm alſo upon the accuracy of the preceding ſyſtems: this has been done both by Buffon and Daubenton, not with leſs truth than humour; for they had too much good ſenſe not to ſee the abſurdity of multiplying the terms of ſcience to no end, and diſappointing our curioſity rather with a catalogue of Nature's varieties, than an hiſtory of Nature.

Inſtead, therefore, of taxing the memory and teizing the patience with ſuch a variety of diviſions and ſubdiviſions, I will take leave to claſs the productions of Nature in the moſt obvious, though not in the moſt accurate manner. In natural hiſtory, of all other ſciences, there is the leaſt danger of obſcurity. In morals, or in metaphyſics, every definition muſt be preciſe, becauſe thoſe ſciences are built upon definitions; but it is otherwiſe in thoſe ſubjects where the exhibition of the object itſelf is always capable of correcting the error. Thus it may often happen that in a lax ſyſtem of natural hiſtory, a creature may be ranked among quadrupeds that belongs more properly to the fiſh or the inſect claſſes. But that can produce very little confuſion, and every reader can thus make a ſyſtem the moſt agreeable to his own imagination. It will be of no manner of conſequence whether we call a bird or an inſect a quadruped, if we are careful in marking all its diſtinctions: the uncertainty in reaſoning, or thinking, that thoſe approximations of the different kinds of animals produce, is but very ſmall, and happens but very rarely; whereas the labour that naturaliſts have been at to keep the kinds aſunder, has been exceſſive. This, in general, has given birth to that variety of ſyſtems which we have juſt mentioned, each of which ſeems to be almoſt as good as the preceding.

Taking, therefore, this latitude, and uſing method only where it contributes to conciſeneſs or perſpicuity, we ſhall divide Animated Nature into four claſſes; namely, Quadrupeds, Birds, Fiſhes, and Inſects. All theſe ſeem in general pretty well diſtinguiſhed from each other by nature; yet there are ſeveral inſtances in which we can ſcarce tell whether it is a bird or quadruped that we are about to examine; whether it is a fiſh or an inſect that offers to our curioſity. Nature is varied by imperceptible gradations, ſo that no line can be drawn between any two claſſes of its productions, and no definition made to comprehend them all. However, the diſtinctions between theſe claſſes are ſufficiently marked, and their encroachments upon each other are ſo rare, that it will be ſufficient particularly to apprize the reader when they happen to be blended.

There are many quadrupeds that we are well acquainted with; and of thoſe we do not know we ſhall form the moſt clear and diſtinct conceptions, by being told wherein they differ and wherein they reſemble thoſe with which we are familiar. Each claſs of quadrupeds may be ranged under ſome one of the domeſtic kinds, that may ſerve for the model by which we are to form ſome kind of idea of the reſt. Thus we may ſay that a tyger is of the cat kind, a wolf of the dog kind, becauſe there are ſome rude reſemblances between each; and a perſon who has never ſeen the wild animals, will have ſome incomplete knowledge of their figure from the tame ones. On the contrary, I will not, as ſome ſyſtematic writers have done*, ſay that a bat is of the human kind, or a hog of the horſe kind, merely becauſe there is ſome reſemblance in their teeth, or their paps. For although this reſemblance may be ſtriking enough, yet a perſon who has never ſeen a bat or a hog, will never form any juſt conception of either, by being told of this minute ſimilitude. In ſhort, the method in claſſing quadrupeds ſhould be taken from their moſt ſtriking reſemblances; and where theſe do not offer, we ſhould not force the ſimilitude, but leave the animal to be deſcribed as a ſolitary ſpecies. The number of quadrupeds is ſo few, that, indeed, without any method whatever, there is no greater danger of confuſion.

All quadrupeds, the number of which, according to Buffon, amounts to about two hundred, may be claſſed in the following manner.

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* Linnæi Syſt.

Firſt, thoſe of the Horſe kind. This claſs contains the Horſe, the Aſs, and the Zebra. Of theſe, none have horns; and their hoof is of one ſolid piece.

The ſecond claſs are thoſe of the Cow kind; comprehending the Urus, the Buffalo, the Biſon, and the Bonaſſus. Theſe have cloven hoofs, and chew the cud.

The third claſs is that of the Sheep kind; with cloven hoofs, and chewing the cud, like the former. In this is comprehended the Sheep, the Goat, the Lama, the Vigogne, the Gazella, the Guinea Deer, and all of a ſimilar form.

The fourth claſs is that of the Deer kind, with cloven hoofs, and with ſolid horns, that are ſhed every year. This claſs contains the Elk, the Rein-deer, the Stag, the Buck, the Roe-buck, and the Axis.

The fifth claſs comprehends all thoſe of the Hog kind, the Peccari, and the Babyroueſſa.

The ſixth claſs is that numerous one of the Cat kind. This comprehends the Cat, the Lion, the Panther, the Leopard, the Jaguar, the Cougar, the Jaguarette, the Lynx, the Ounce, and the Catamountain. Theſe are all carnivorous, and furniſhed with crooked claws, which they can ſheath and unſheath at pleaſure.

The ſeventh claſs is that of the Dog kind, carnivorous, and furniſhed with claws like the former, but which they cannot ſheath. This claſs comprehends the Dog, the Wolf, the Fox, the Jackall, the Iſatis, the Hyena, the Civette, the Gibet, and the Genet.

The eighth claſs is that of the Weaſel kind, with a long ſmall body, with five toes, or claws, on each foot; the firſt of them ſeparated from the reſt like a thumb. This comprehends the Weaſel, the Martin, the Pole-cat, the Ferrit, the Mangouſt, the Vanſire, the Ermine, with all the varieties of the American Mouſettes.

The ninth claſs is that of the Rabbit kind, with two large cutting teeth in each jaw. This comprehends the Rabbit, the Hare, the Guinea-pig, all the various ſpecies of the Squirrel, the Dormouſe, the Marmotte, the Rat, the Mouſe, Agouti, the Paca, the Aperea, and the Tapeti.

The tenth claſs is that of the Hedge-hog kind, with claw feet, and covered with prickles, comprehending the Hedge-hog and the Porcupine, the Couando, and the Urſon.

The eleventh claſs is that of the Tortoiſe kind, covered with a ſhell, or ſcales. This comprehends the Tortoiſe, the Pangolin, and the Phataguin.

The twelfth is that of the Otter, or amphibious kind, comprehending the Otter, the Beaver, the Deſman, the Morſe, and the Seal.

The thirteenth claſs is that of the Ape and Monkey kinds, with hands, and feet reſembling hands.

The fifteenth claſs is that of winged quadrupeds, or the Bat kind, containing the Bat, the Flying Squirrel, and ſome other varieties.

The animals which ſeem to approach no other kind, either in nature, or in form, but to make each a diſtinct ſpecies in itſelf, are the following: the Elephant, the Rhinoceros, the Hippopotamos, the Camelopard, the Camel, the Bear, the Badger, the Tapir, the Cabiai, the Coati, the Antbear, the Tatau, and laſtly the Sloth.

All other quadrupeds, whoſe names are not ſet down, will be found among ſome of the above mentioned claſſes, and referred to that which they moſt reſemble. When, therefore, we are at a loſs to know the name of any particular animal, by examining which of the known kinds it moſt reſembles, either in ſhape, or in hoofs, or claws; and then, examining the particular deſcription, we ſhall be able to diſcover not only its name, but its hiſtory. I have already ſaid that all methods of this kind are merely arbitrary, and that Nature makes no exact diſtinction between her productions. It is hard, for inſtance, to tell whether we ought to refer the civet to the dog, or the cat kind; but, if we know the exact hiſtory of the civet, it is no great matter to which kind we ſhall judge it to bear the greateſt reſemblance. It is enough that a deſtribution of this kind excites in us ſome rude out-lines of the make, or ſome marked ſimilitudes in the nature of theſe animals; but, to know them with any preciſion, no ſyſtem, or even deſcription will ſerve, ſince the animal itſelf, or a good print of it, muſt be ſeen, and its hiſtory be read at length, before it can be ſaid to known. To pretend to ſay that we have an idea of a quadruped, becauſe we can tell the number, or the make of its teeth, or its paps, is as abſurd as if we ſhould pretend to diſtinguiſh men by the buttons on their clothes. Indeed it often happens that the quadruped itſelf can be but ſeldom ſeen, that many of the more rare kinds do not come into Europe above once in an age, and ſome of them have never been able to bear the removal; in ſuch a caſe, therefore, there is no other ſubſtitute but a good print of the animal to give an idea of its figure; for no deſcription whatſoever can anſwer this purpoſe ſo well. Mr. Locke, with his uſual good ſenſe, has obſerved, that a drawing of the animal, taken from the life, is one of the beſt methods of advancing natural hiſtory; and yet, moſt of our modern ſyſtematic writers are content rather with deſcribing. Deſcriptions, no doubt, will go ſome way towards giving an idea of the figure of an animal; but they are certainly much the longeſt way about, and, as they are uſually managed, much the moſt obſcure. In a drawing we can, at a ſingle glance, gather more inſtruction than by a day's painful inveſtigation of methodical ſyſtems, where we are told the proportions with great exactneſs, and yet remain ignorant of the totality. In fact, this method of deſcribing all things is a fault that has infected many of our books, that treat on the meaner arts for this laſt age. They attempt to teach by words, what is only to be learnt by practice and inſpection. Moſt of our dictionaries, and bodies of arts and ſciences, are guilty of this error. Suppoſe, for inſtance, it be requiſite to mention the manner of making ſhoes, it is plain that all the verbal inſtructions in the world will never give an adequate idea of this humble art, or teach a man to become a ſhoe-maker. A day or two in a ſhoemaker's ſhop will anſwer the end better than a whole folio of inſtruction, which only ſerves to oppreſs the learner with the weight of its pretended importance. We have lately ſeen a laborious work carried on at Paris, with this only intent of teaching all the trades by deſcription; however, the deſign at firſt bluſh ſeems to be ill conſidered; and it is probable that very few advantages will be derived from ſo laborious an undertaking. With regard to the deſcriptions in natural hiſtory, theſe, without all queſtion, under the direction of good ſenſe, are neceſſary; but ſtill they ſhould be kept within proper bounds; and, where a thing may be much more eaſily ſhewn than deſcribed, the exhibition ſhould ever precede the account.

CHAP. XV.

OF QUADRUPEDS IN GENERAL, COMPARED TO MAN.

UPON comparing the various animals of the globe with each other, we ſhall find that Quadrupeds demand the rank immediately next ourſelves; and, conſequently, come firſt in conſideration. The ſimilitude between the ſtructure of their bodies and ours, thoſe inſtincts which they enjoy in a ſuperior degree to the reſt, their conſtant ſervices, or their unceaſing hoſtilities, all render them the foremoſt objects of our curioſity, and the moſt intereſting parts of Animated Nature. Theſe, however, although now ſo completely ſubdued, very probably, in the beginning, were nearer upon an equality with us, and diſputed the poſſeſſion of the earth. Man, while yet ſavage himſelf, was but ill qualified to civilize the foreſt. While yet naked, unarmed, and without ſhelter, every wild beaſt was a formidable rival; and the deſtruction of ſuch was the firſt employment of heroes. But when he began to multiply, and arts to accumulate, he ſoon cleared the plains of the moſt noxious of theſe his rivals; a part was taken under his protection and care, while the reſt found a precarious refuge in the burning deſert, or the howling wilderneſs.

From being rivals, quadrupeds have now become the aſſiſtants of man; upon them he devolves the moſt laborious employments, and finds in them patient and humble coadjutors, ready to obey, and content with the ſmalleſt retribution. It was not, however, without long and repeated efforts that the independent ſpirit of theſe animals was broken; for the ſavage freedom, in wild animals, is generally found to paſs down through ſeveral generations before it is totally ſubdued. Thoſe cats and dogs that are taken from a ſtate of natural wildneſs in the foreſt, tranſmit their fierceneſs to their young: and, however concealed in general, it breaks out upon ſeveral occaſions. Thus the aſſiduity and application of man in bringing them up, not only alters their diſpoſition, but their very forms; and the difference between animals in a ſtate of nature and domeſtic tameneſs, is ſo conſiderable, that Mr. Buffon has taken this as a principal diſtinction in claſſing them.

In taking a curſory view of the form of quadrupeds we may eaſily perceive that of all the ranks of Animated Nature, they bear the neareſt reſemblance to man. This ſimilitude will be found more ſtriking when erecting themſelves on their hinder feet, they are taught to walk forward in an upright poſture. We then ſee that all their extremities in a manner correſpond with ours, and preſent us with a rude imitation of our own. In ſome of the ape kind the reſemblance is ſo ſtriking, that anatomiſts are puzzled to find in what part of the human body man's ſuperiority conſiſts; and ſcarce any but the metaphyſician can draw the line that ultimately divides them.

But if we compare their internal ſtructure with our own, the likeneſs will be found ſtill to increaſe, and we ſhall perceive many advantages they enjoy in common with us, above the lower tribes of Nature. Like us, they are placed above the claſs of birds, by bringing forth their young alive; like us, they are placed above the claſs of fiſhes, by breathing through the lungs; like us, they are placed above the claſs of inſects, by having red blood circulating through their veins; and, laſtly, like us, they are different from almoſt all the other claſſes of Animated Nature, being either wholly or partly covered with hair. Thus nearly are we repreſented in point of conformation to the claſs of animals immediately below us; and this ſhews what little reaſon we have to be proud of our perſons alone, to the perfection of which quadrupeds make ſuch very near approaches.

The ſimilitude of quadrupeds to man obtains alſo in the fixedneſs of their nature, and their being leſs apt to be changed by the influence of climate or food, than the lower ranks of Nature *. Birds are found very apt to alter both in colour and ſize; fiſhes, likewiſe, ſtill more; inſects may be quickly brought to change and adapt themſelves to the climate; and if we deſcend to plants, which may be allowed to have a kind of living exiſtence, their kinds may be ſurpriſingly and readily altered, and taught to aſſume new

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* Buffon, vol. xviii. p. 179.

forms. The ſigure of every animal may be conſidered as a kind of drapery, which it may be made to put on or off by human aſſiduity; in man the drapery is almoſt invariable; in quadrupeds it admits of ſome variation; and the variety may be made greater ſtill, as we deſcend to the inferior claſſes of animal exiſtence.

Quadrupeds, although they are thus ſtrongly marked, and in general divided from the various kinds around them, yet ſome of them are often of ſo equivocal a nature, that it is hard to tell whether they ought to be ranked in the quadruped claſs, or degraded to thoſe below them. If, for inſtance, we were to marſhal the whole group of animals round man, placing the moſt perfect next him, and thoſe moſt equivocal near the claſſes they moſt approach, we ſhould find it difficult, after the principal had taken their ſtations near him, where to place many that lie at the out-ſkirts of this phalanx. The bat makes a near approach to the aerial tribe, and might, by ſome, be reckoned among the birds. The porcupine has not leſs pretenſions to that claſs, being covered with quills, and ſhewing that birds are not the only part of Nature that are furniſhed with ſuch a defence. The armadilla might be referred to the tribe of inſects, or ſnails, being, like them, covered with a ſhell; the ſeal and the morſe might be ranked among the fiſhes, like them being furniſhed with fins, and almoſt conſtantly reſiding in the ſame element. All theſe, the farther they recede from the human figure, become leſs perfect, and may be conſidered as the loweſt kinds of that claſs to which we have referred them.

But although the variety in quadrupeds is thus great, they all ſeem well adapted to the ſtations in which they are placed. There is ſcarce one of them, how rudely ſhaped ſoever, that is not formed to enjoy a ſtate of happineſs fitted to its nature. All its deformities are only relative to us, but all its enjoyments are peculiarly its own. We may ſuperficially ſuppoſe the ſloth, that takes up months in climbing a ſingle tree, or the mole, whoſe eyes are too ſmall for diſtinct viſion, are wretched and helpleſs creatures; but it is probable that their life, with reſpect to themſelves, is a life of luxury;

the moſt pleaſing food is eaſily obtained; and, as they are abridged in one pleaſure, it may be doubled in thoſe which remain. Quadrupeds, and all the lower kinds of animals, have, at worſt, but the torments of immediate evil to encounter, and this is but tranſient and accidental; man has two ſources of calamity, that which he foreſees, as well as that which he feels; ſo that, if his reward were to be in this life alone, then, indeed, would he be of all beings the moſt wretched.

The heads of quadrupeds, though differing from each other, are, in general, adapted to their way of living. In ſome it is ſharp, the better to fit the animal for turning up the earth in which its food lies. In ſome it is long, in order to give a greater room for the olfactory nerves, as in dogs, who are to hunt and find out their prey by the ſcent. In others it is ſhort and thick, as in the lion, to increaſe the ſtrength of the jaw, and to fit it the better for combat. In quadrupeds, that feed upon graſs, they are enabled to hold down their heads to the ground, by a ſtrong tendinous ligament, that runs from the head to the middle of the back. This ſerves to raiſe the head, although it has been held to the ground for ſeveral hours, without any labour, or any aſſiſtance from the muſcles of the neck.

The teeth of all animals are entirely fitted to the nature of their food. Thoſe of ſuch as live upon fleſh differ in every reſpect from ſuch as live upon vegetables. In the latter, they ſeem entirely made for gathering and bruiſing their ſimple food, being edged before, and fitted for cutting; but broad towards the back of the jaw, and fitted for pounding. In the carnivorous kinds, they are ſharp before, and fitted rather for holding than dividing. In the one, the teeth ſerve as grindſtones, in the other, as weapons of defence; in both, however, the ſurface of thoſe teeth which ſerve for grinding are unequal; the cavities and riſings fitting thoſe of the oppoſite, ſo as to tally exactly when the jaws are brought together. Theſe inequalities better ſerve for comminuting the food; but they become ſmooth with age; and, for this reaſon, old animals take a longer time to chew their food than ſuch as are in the vigour of life.

Their legs are not better fitted than their teeth to their reſpective wants or enjoyments. In ſome they are made for ſtrength only, and to ſupport a vaſt unwieldy frame, without much flexibility or beautiful proportion. Thus the legs of the elephant, the rhinoceros, and the ſea-horſe, reſemble pillars; were they made ſmaller they would be unfit to ſupport the body; were they endowed with greater flexibility, or ſwiftneſs, that would be needleſs, as they do not purſue other animals for food; and, conſcious of their own ſuperior ſtrength, there are none that they deign to avoid. Deers, hares, and other creatures, that are to find ſafety only in flight, have their legs made entirely for ſpeed; they are ſlender and nervous. Were it not for this advantage, every carnivorous animal would ſoon make them a prey, and their races would be entirely extinguiſhed. But, in the preſent ſtate of Nature, the means of ſafety are rather ſuperior to thoſe of offence; and the purſuing animal muſt owe ſucceſs only to patience, perſeverance, and induſtry. The feet of ſome, that live upon fiſh alone, are made for ſwimming.—The toes of theſe animals are joined together with membranes, being web-footed, like a gooſe or a duck, by which they ſwim with great rapidity. Thoſe animals that lead a life of hoſtility, and live upon others, have their feet armed with ſharp claws, which ſome can ſheath and unſheath at will. Thoſe, on the contrary, who lead peaceful lives, have generally hoofs, which ſerve ſome as weapons of defence; and which, in all, are better fitted for traverſing extenſive tracts of rugged country, than the claw-foot of their purſuers.

The ſtomach is generally proportioned to the quality of the animal's food, or the eaſe with which it is obtained. In thoſe that live upon fleſh, and ſuch nouriſhing ſubſtances, it is ſmall and glandular, affording ſuch juices as are beſt adapted to digeſt its contents; their inteſtines, alſo, are ſhort, and without fatneſs. On the contrary, ſuch animals as feed entirely upon vegetables, have the ſtomach very large; and and thoſe who chew the cud have no leſs than four ſtomachs, all which ſerve as ſo many laboratories, to prepare and turn their coarſe food into proper nouriſhment. In Africa, where the plants afford greater nouriſhment than in our temperate climates, ſeveral animals, that with us have four ſtomachs, have there but two *. However, in all animals the ſize of the inteſtines are proportioned to the nature of the food; where that is furniſhed in large quantities, the ſtomach dilates to anſwer the increaſe. In domeſtic animals, that are plentifully ſupplied, it is large; in the wild animals, that live precariouſly, it is much more contracted, and the inteſtines are much ſhorter.

In this manner, all animals are fitted by Nature to fill up ſome peculiar ſtation. The greateſt animals are made for an inoffenſive life, to range the plains and the foreſt without injuring others; to live upon the productions of the earth, the graſs of the field, or the tender branches of trees. Theſe, ſecure in their own ſtrength, neither fly from any other quadrupeds nor yet attack them: Nature, to the greateſt ſtrength, has added the moſt gentle and harmleſs diſpoſitions; without this, thoſe enormous creatures would be more than a match for all the reſt of the creation; for what devaſtation might not enſue were the elephant, or the rhinoceros, or the buffalo, as fierce and as miſchievous as the tiger or the rat? In order to oppoſe theſe larger animals, and in ſome meaſure to prevent their exuberance, there is a ſpecies of the carnivorous kind, of inferior ſtrength indeed, but of greater activity and cunning. The lion and the tiger generally watch for the larger kinds of prey, attack them at ſome diſadvantage, and commonly jump upon them by ſurpriſe. None of the carnivorous kinds, except the dog alone, will make a voluntary attack, but with the odds on their ſide. They are all cowards by nature, and uſually catch their prey by a bound from ſome lurking place, ſeldom attempting to invade them openly; for the larger beaſts are too powerful for them, and the ſmaller too ſwift.

A lion does not willingly attack an horſe; and then only when compelled by the keeneſt hunger. The combats between a lion and a horſe are frequent enough in Italy; where they are both incloſed in a kind of amphitheatre, fitted for that purpoſe. The lion always approaches wheeling about, while the horſe preſents his hinder parts to the enemy. The lion in this manner goes round and round, ſtill narrowing

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* Buffon.

his circle, till he comes to the proper diſtance to make his ſpring; juſt at the time the lion ſprings, the horſe laſhes with both legs from behind, and, in general, the odds are in his favour; it more often happening that the lion is ſtunned, and ſtruck motionleſs by the blow, than that he effects his jump between the horſe's ſhoulders. If the lion is ſtunned, and left ſprawling, the horſe eſcapes, without attempting to improve his victory; but if the lion ſucceeds, he ſticks to his prey, and tears the horſe in pieces in a very ſhort time.

But it is not among the larger animals of the foreſt alone, that theſe hoſtilities are carried on; there is a minuter, and a ſtill more treacherous conteſt between the lower ranks of quadrupeds. The panther hunts for the ſheep and the goat; the catamountain, for the hare or the rabbit; and the wild cat for the ſquirrel or the mouſe. In proportion as each carnivorous animal wants ſtrength, it uſes all the aſſiſtance of patience, aſſiduity, and cunning. However, the arts of theſe to purſue, are not ſo great as the tricks of their prey to eſcape; ſo that the power of deſtruction in one claſs, is inferior to the power of ſafety in the other. Were this otherwiſe, the foreſt would ſoon be diſpeopled of the feebler races of animals; and beaſts of prey themſelves, would want, at one time, that ſubſiſtence which they laviſhly deſtroyed at another.

Few wild animals ſeek their prey in the day-time; they are then generally deterred by their fears of man in the inhabited countries, and by the exceſſive heat of the ſun in thoſe extenſive foreſts that lie towards the ſouth, and in which they reign the undiſputed tyrants. As ſoon as the morning, therefore, appears, the carnivorous animals retire to their dens; and the elephant, the horſe, the deer, and all the hare kinds, thoſe inoffenſive tenants of the plain, make their appearance. But again, at night-fall, the ſtate of hoſtility begins; the whole foreſt then echoes to a variety of different howlings. Nothing can be more terrible than an African landſcape at the cloſe of evening: the deep toned roarings of the lion; the ſhriller yellings of the tiger; the jackall, purſuing by the ſcent, and barking like a dog; the hyæna, with a note peculiarly ſolitary and dreadful; but above all, the hiſſing of the various kinds of ſerpents, that then begin their call, and, as I am aſſured, make a much louder ſymphony than the birds in our groves in a morning.

Beaſts of prey ſeldom devour each other; nor can any thing but the greateſt degree of hunger induce them to it. What they chiefly ſeek after, is the deer, or the goat; thoſe harmleſs creatures, that ſeem made to embelliſh Nature. Theſe are either purſued or ſurpriſed, and afford the moſt agreeable repaſt to their deſtroyers. The moſt uſual method with even the fierceſt animals, is to hide and crouch near ſome path frequented by their prey; or ſome water, where cattle come to drink; and ſeize them at once with a bound. The lion and the tiger leap twenty feet at a ſpring; and this, rather than their ſwiftneſs or ſtrength, is what they have moſt to depend upon for a ſupply. There is ſcarce one of the deer or hare kind, that is not very eaſily capable of eſcaping them by its ſwiftneſs; ſo that whenever any of theſe fall a prey, it muſt be owing to their own inattention.

But there is another claſs of the carnivorous kind, that hunt by the ſcent, and which it is much more difficult to eſcape. It is remarkable, that all animals of this kind purſue in a pack; and encourage each other by their mutual cries. The jackall, the ſyaguſh, the wolf, and the dog, are of this kind: they purſue with patience rather than ſwiftneſs; their prey flies at firſt, and leaves them for miles behind; but they keep on with a conſtant ſteady pace, and excite each other by a general ſpirit of induſtry and emulation, till at laſt they ſhare the common plunder. But it too often happens, that the larger beaſts of prey, when they hear a cry of this kind begun, purſue the pack, and when they have hunted down the animal, come in and monopolize the ſpoil. This has given riſe to the report of the jackall's being the lion's provider; when the reality is, that the jackall hunts for itſelf, and the lion is an unwelcome intruder upon the fruit of his toil.

Nevertheleſs, with all the powers which carnivorous animals are poſſeſſed of, they generally lead a life of famine and fatigue. Their prey has ſuch a variety of methods for eſcaping, that they ſometimes continue without food for a fortnight together: but Nature has endowed them with a degree of patience, equal to the ſeverity of their ſtate; ſo that as their ſubſiſtence is precarious, their appetites are complying. They uſually ſeize their prey with a roar, either of ſeeming delight, or perhaps to terrify it from reſiſtance. They frequently devour it, bones and all, in the moſt ravenous manner; and then retire to their dens, continuing inactive till the calls of hunger again excite their courage and induſtry. But as all their methods of purſuit are counteracted by the arts of evaſion, they often continue to range without ſucceſs, ſupporting a ſtate of famine for ſeveral days, nay, ſometimes, weeks together. Of their prey, ſome find protection in holes, in which Nature has directed them to bury themſelves; ſome find ſafety by ſwiftneſs; and ſuch as are poſſeſſed of neither of theſe advantages, generally herd together, and endeavour to repel invaſion by united force. The very ſheep, which to us ſeem ſo defenceleſs, are by no means ſo in a ſtate of Nature; they are furniſhed with arms of defence, and a very great degree of ſwiftneſs; but they are ſtill further aſſiſted by their ſpirit of mutual defence: the females fall into the centre; and the males, forming a ring round them, oppoſe their horns to the aſſailants. Some animals, that feed upon fruits which are to be found only at one time of the year, fill their holes with ſeveral ſorts of plants, which enable them to lie concealed during the hard froſts of the winter, contented with their priſon, ſince it affords them plenty and protection. Theſe holes are dug with ſo much art, that there ſeems the deſign of an architect in the formation. There are uſually two apertures, by one of which the little inhabitant can always eſcape, when the enemy is in poſſeſſion of the other. Many creatures are equally careful of avoiding their enemies, by placing a centinel, to warn them of the approach of danger. Theſe generally perform this duty by turns; and they know how to puniſh ſuch as have neglected their poſt, or have been unmindful of the common ſafety. Such are a part of the efforts that the weaker races of quadrupeds exert, to avoid their invaders; and, in general, they are attended with ſucceſs. The arts of inſtinct are moſt commonly found an overmatch for the invaſions of inſtinct. Man is the only creature againſt whom all their little tricks cannot prevail. Wherever he has ſpread his dominion, ſcarce any flight can ſave, or any retreat harbour; wherever he comes, terror ſeems to follow, and all ſociety ceaſes among the inferior tenants of the plain; their union againſt him can yield them no protection, and their cunning is but weakneſs. In their fellow brutes, they have an enemy whom they can oppoſe with an equality of advantage; they can oppoſe fraud or ſwiftneſs to force; or numbers to invaſion: but what can be done againſt ſuch an enemy as man, who finds them out though unſeen, and though remote deſtroys them? Wherever he comes, all the conteſt among the meaner ranks ſeem to be at an end, or is carried only by ſurpriſe. Such as he has thought proper to protect, have calmly ſubmitted to his protection; ſuch as he has found convenient to deſtroy, carry on an unequal war, and their numbers are every day decreaſing.

The wild animal is ſubject to few alterations; and, in a ſtate of ſavage nature, continues for ages the ſame, in ſize, ſhape, and colour. But it is otherwiſe when ſubdued, and taken under the protection of man; its external form, and even its internal ſtructure, are altered by human aſſiduity: and this is one of the firſt and greateſt cauſes of the variety that we ſee among the ſeveral quadrupeds of the ſame ſpecies. Man appears to have changed the very nature of domeſtic animals, by cultivation and care. A domeſtic animal is a ſlave that ſeems to have few other deſires but ſuch as man is willing to allow it. Humble, patient, reſigned, and attentive, it fills up the duties of its ſtation; ready for labour, and content with ſubſiſtence.

Almoſt all domeſtic animals ſeem to bear the marks of ſervitude ſtrong upon them. All the varieties in their colour, all the fineneſs and length of their hair, together with the depending length of their ears, ſeem to have ariſen from a long continuance of domeſtic ſlavery. What an immenſe variety is there to be found in the ordinary race of dogs and horſes! the principal differences of which has been effected by the induſtry of man, ſo adapting the food, the treatment, the labour, and the climate, that Nature ſeems almoſt to have forgotten her original deſign; and the tame animal no longer bears any reſemblance to its anceſtors in the woods around him.

In this manner, Nature is under a kind of conſtraint, in thoſe animals we have taught to live in a ſtate of ſervitude near us. The ſavage animals preſerve the marks of their firſt formation; their colours are generally the ſame; a rough duſky brown, or a tawny, ſeem almoſt their only varieties. But it is otherwiſe in the tame; their colours are various, and their forms different from each other. The nature of the climate, indeed, operates upon all; but more particularly on theſe. That nouriſhment which is prepared by the hand of man, not adapted to their appetites, but to ſuit his own convenience, that climate, the rigours of which he can ſoften, and that employment to which they are ſometimes aſſigned, produce a number of diſtinctions that are not to be found among the ſavage animals. Theſe at firſt were accidental, but in time became hereditary; and a new race of artificial monſters are propagated, rather to anſwer to the purpoſes of human pleaſure, than their own convenience. In ſhort, their very appetites may be changed; and thoſe that feed only upon graſs, may be rendered carnivorous. I have ſeen a ſheep that would eat fleſh, and an horſe that was fond of oyſters. ×

But not their appetites, or their figure alone, but their very diſpoſitions, and their natural ſagacity, are altered by the vicinity of man. In thoſe countries where men have ſeldom intruded, ſome animals have been found, eſtabliſhed in a kind of civil ſtate of ſociety. Remote from the tyranny of man, they ſeem to have a ſpirit of mutual benevolence, and mutual friendſhip. The beavers, in theſe diſtant ſolitudes, are known to build like architects, and rule like citizens. The habitations that theſe have been ſeen to erect, exceed the houſes of the human inhabitants of the ſame country, both in neatneſs and convenience. But as ſoon as man intrudes upon their ſociety, they ſeem impreſſed with the terrors of their inferior ſituation, their ſpirit of ſociety ceaſes, the bond is diſſolved, and every animal looks for ſafety in ſolitude, and there tries all its little induſtry to ſhift only for itſelf.

Next to human influence, the climate ſeems to have the ſtrongeſt effects both upon the nature and form of quadrupeds. As in man, we have ſeen ſome alterations, produced by the variety of his ſituation; ſo in the lower ranks that are more ſubject to variation, the influence of climate is more readily perceived. As theſe are more nearly attached to the earth, and in a manner connected to the ſoil; as they have none of the arts of ſhielding off the inclemency of the weather, or ſoftening the rigours of the ſun, they are conſequently more changed by its variations. In general, it may be remarked, that the colder the country, the larger and the warmer is the fur of each animal; it being wiſely provided by Nature, that the inhabitant ſhould be adapted to the rigours of its ſituation. Thus the fox and wolf, which in temperate climates have but ſhort hair, have a fine long fur in the frozen regions near the pole. On the contrary, thoſe dogs which with us have long hair, when carried to Guinea, or Angola, in a ſhort time caſt their thick covering, and aſſume a lighter dreſs, and one more adapted to the warmth of the country. The beaver, and the ermine, which are found in the greateſt plenty in the cold regions, are remarkable for the warmth and delicacy of their furs; while the elephant, and the rhinoceros, that are natives of the line, have ſcarce any hair. Not but that human induſtry can, in ſome meaſure, co-operate with, or repreſs the effects of climate in this particular. It is well known what alterations are produced by proper care, in the ſheep's fleece, in different parts of our own country; and the ſame induſtry is purſued with a like ſucceſs in Syria, where many of their animals are clothed with a long and beautiful hair, which they take care to improve, as they work it into that ſtuff called camblet, ſo well known in different parts of Europe.

The diſpoſition of the animal ſeems alſo not leſs marked by the climate than the figure. The ſame cauſes that ſeem to have rendered the human inhabitants of the rigorous climates ſavage and ignorant, have alſo operated upon their animals. Both at the line and the pole, the wild quadrupeds are fierce and untameable. In theſe latitudes, their ſavage diſpoſitions having not been quelled by any efforts from man, and being ſtill farther ſtimulated by the ſeverity of the weather, they continue fierce and untractable. Moſt of the attempts which have hitherto been made to tame the wild beaſts brought home from the pole or the equator, have proved ineffectual. They are gentle and harmleſs enough while young; but as they grow up, they acquire their natural ferocity, and ſnap at the hand that feeds them. It may indeed, in general, be aſſerted, that in all countries where the men are moſt barbarous, the beaſts are moſt fierce and cruel: and this is but a natural conſequence of the ſtruggle between man and the more ſavage animals of the foreſt; for in proportion as he is weak and timid, they muſt be bold and intruſive; in proportion as his dominion is but feebly ſupported, their rapacity muſt be more obnoxious. In the extenſive countries, therefore, lying round the pole, or beneath the line, the quadrupeds are fierce and formidable. Africa has ever been remarked for the brutality of its men, and the fierceneſs of its animals: its lions and its leopards are not leſs terrible than its crocodiles and its ſerpents; their diſpoſitions ſeem entirely marked with the rigours of the climate; and being bred in an extreme of heat, they ſhew a peculiar ferocity, that neither the force of man can conquer, nor his arts allay. However, it is happy for the wretched inhabitants of thoſe climates, that its moſt formidable animals are all ſolitary ones; that they have not learnt the art of uniting, to oppreſs mankind; but each, depending on its own ſtrength, invades without any aſſiſtant.

The food alſo is another cauſe in the variety, which we find among the quadrupeds of the ſame kind. Thus the beaſts which feed in the valley are generally larger than thoſe which glean a ſcanty ſubſiſtence on the mountain. Such as live in the warm climates, where the plants are much larger and more ſucculent than with us, are equally remarkable for their bulk. The ox fed in the plains of Indoſtan, is much larger than that which is more hardily maintained on the ſide of the Alps. The deſerts of Africa, where the plants are extremely nouriſhing, produce the largeſt and fierceſt animals; and, perhaps, for a contrary reaſon, America is found not to produce ſuch large animals as are ſeen in the ancient continent. But, whatever be the reaſon, the fact is certain, that while America exceeds us in the ſize of its reptiles of all kinds, it is far inferior in its quadruped productions. Thus, for inſtance, the largeſt animal of that country is the tapir, which can by no means be compared to the elephant of Africa. Its beaſts of prey alſo, are diveſted of that ſtrength and courage which is ſo dangerous in this part of the world. The American lion, tiger, and leopard, if ſuch diminutive creatures deſerve theſe names, are neither ſo fierce nor ſo valiant as thoſe of Africa and Aſia. The tiger of Bengal has been ſeen to meaſure twelve feet in length, without including the tail; whereas the American tiger ſeldom exceeds three. This difference obtains ſtill more in the other animals of that country, ſo that ſome have been of opinion * that all quadrupeds in Southern America are of a different ſpecies from thoſe moſt reſembling them in the old world; and that there are none which are common to both but ſuch as have entered America by the north; and which, being able to bear the rigours of the frozen pole, have travelled from the ancient continent, by that paſſage, into the new. Thus the bear, the wolf, the elk, the ſtag, the fox, and the beaver, are known to the inhabitant as well of North America as of Ruſſia; while moſt of the various kinds to the ſouthward, in both continents, bear no reſemblance to each other. Upon the whole, ſuch as peculiarly belong to the new continent are without any marks of the quadruped perfection. They are almoſt wholly deſtitute of the power of defence; they have neither formidable teeth, horns, nor tail; their figure is awkward, and their limbs ill-proportioned. Some among them, ſuch as the ant-bear, and the ſloth, appear ſo miſerably formed, as ſcarce to have the power of moving and eating. They, ſeemingly, drag out a miſerable and languid exiſtence in the moſt deſert ſolitude; and would quickly have been deſtroyed in a country where there were inhabitants, or powerful beaſts to oppoſe them.

But, if the quadrupeds of the new continent be leſs, they are found in much greater abundance; for it is a rule that obtains through Nature, that the ſmalleſt animals multiply the faſteſt. The goat, imported from Europe to South America, ſoon begins to degenerate; but as it grows leſs it becomes more prolific; and, inſtead of one kid at a time, or two at the moſt, it generally produces five, and ſometimes more. What there is in the food, or the climate,

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* Buffon.

that produces this change, we have not been able to learn; we might be apt to aſcribe it to the heat, but that on the African coaſt, where it is ſtill hotter, this rule does not obtain; for the goat, inſtead of degenerating there, ſeems rather to improve.

However, the rule is general among all quadrupeds, that thoſe which are large and formidable produce but a few at a time: while ſuch as are mean and contemptible are extremely prolific. The lion, or tiger, have ſeldom above two cubs at a litter; while the cat, that is of a ſimilar nature, is uſually ſeen to have five or ſix. In this manner, the lower tribes become extremely numerous; and, but for this ſurpriſing fecundity, from their natural weakneſs, they would quickly be extirpated. The breed of mice, for inſtance, would have long ſince been blotted from the earth, were the mouſe as ſlow in production as the elephant. But it has been wiſely provided that ſuch animals as can make but little reſiſtance, ſhould at leaſt have a means of repairing the deſtruction, which they muſt often ſuffer, by their quick reproduction; that they ſhould increaſe even among enemies, and multiply under the hand of the deſtroyer. On the other hand, it has as wiſely been ordered by Providence, that the larger kinds ſhould produce but ſlowly; otherwiſe, as they require proportional ſupplies from Nature, they would quickly conſume their own ſtore; and, of conſequence, many of them would ſoon periſh through want; ſo that life would thus be given without the neceſſary means of ſubſiſtence. In a word, Providence has moſt wiſely balanced the ſtrength of the great againſt the weakneſs of the little. Since it was neceſſary that ſome ſhould be great and others mean, ſince it was expedient that ſome ſhould live upon others, it has aſſiſted the weakneſs of one by granting it fruitfulneſs; and diminiſhed the number of the other by infecundity.

In conſequence of this proviſion, the larger creatures, which bring forth few at a time, ſeldom begin to degenerate till they have nearly acquired their full growth. On the contrary, thoſe which bring many, reproduce before they have arrived at half their natural ſize. Thus the horſe and the bull are nearly at their beſt before they begin to breed; the hog and the rabbit ſcarce leave the teat before they become parents in turn. Almoſt all animals likewiſe continue the time of their pregnancy in proportion to their ſize. The mare continues eleven months with foal, the cow nine, the wolf five, and the bitch nine weeks. In all, the intermediate litters are the moſt fruitful; the firſt and the laſt generally producing the feweſt in number and the worſt of the kind.

Whatever be the natural diſpoſition of animals at other times, they all acquire new courage when they conſider themſelves as defending their young. No terrors can then drive them from the poſt of duty; the mildeſt begin to exert their little force, and reſiſt the moſt formidable enemy. Where reſiſtance is hopeleſs, they then incur every danger, in order reſcue their young by flight, and retard their own expedition by providing for their little ones. When the female opoſſum, an animal of America, is purſued, ſhe inſtantly takes her young into a falſe belly, with which Nature has ſupplied her, and carries them off, or dies in the endeavour. I have been lately aſſured of a ſhe-fox which, when hunted, took her cub in her mouth, and run for ſeveral miles without quitting it, until at laſt ſhe was forced to leave it behind, upon the approach of a maſtiff, as ſhe ran through a farmer's yard. But, if at this period the mildeſt animals acquire new fierceneſs, how formidable muſt thoſe be that ſubſiſt by rapine! At ſuch times, no obſtacles can ſtop their ravage, nor no threats can terrify; the lioneſs then ſeems more hardy than even the lion himſelf. She attacks men and beaſts indiſcriminately, and carries all ſhe can overcome reeking to her cubs, whom ſhe thus early accuſtoms to ſlaughter: Milk, in the carnivorous animals, is much more ſparing than in others; and it may be for this reaſon that all ſuch carry home their prey alive, that, in feeding their young, its blood may ſupply the deficiences of Nature, and ſerve inſtead of that milk, with which they are ſo ſparingly ſupplied.

Nature, that has thus given them courage to defend their young, has given them inſtinct to chooſe the proper times of copulation, ſo as to bring forth when the proviſion ſuited to each kind is to be found in the greateſt plenty. The wolf, for inſtance, couples in December, ſo that the time of pregnancy continuing five months it may have its young in

April. The mare, who goes eleven months, admits the horſe in ſummer, in order to foal about the beginning of May. On the contrary, thoſe animals which lay up proviſions for the winter, ſuch as the beaver and the marmotte, couple in the latter end of autumn, ſo as to have their young about January, againſt which ſeaſon they have provided a very comfortable ſtore. Theſe ſeaſons for coupling, however, among ſome of the domeſtic kinds, are generally in conſequence of the quantity of proviſions with which they are at any time ſupplied. Thus we may, by feeding any of theſe animals, and keeping off the rigour of the climate, make them breed whenever we pleaſe. In this manner thoſe contrive who produce lambs all the year round.

The choice of ſituation in bringing forth is alſo very remarkable. In moſt of the rapacious kinds, the female takes the utmoſt precautions to hide the place of her retreat from the male; who otherwiſe, when preſſed by hunger, would be apt to devour her cubs. She ſeldom, therefore, ſtrays far from the den, and never approaches it while he is in view, nor viſits him again till her young are capable of providing for themſelves. Such animals as are of tender conſtitutions take the utmoſt care to provide a place of warmth as well as ſafety, for their young; the rapacious kinds bring forth in the thickeſt woods; thoſe that chew the cud, with the various tribes of the vermin kind, chooſe ſome hiding-place in the neighbourhood of man. Some dig holes in the ground; ſome chooſe the hollow of a tree; and all the amphibious kinds bring up their young near the water, and accuſtom them betimes to their proper element.

Thus Nature ſeems kindly careful for the protection of the meaneſt of her creatures: but there is one claſs of quadrupeds that ſeems entirely left to chance, that no parent ſtands forth to protect, nor no inſtructor leads, to teach the arts of ſubſiſtence. Theſe are the quadrupeds that are brought forth from the egg, ſuch as the lizard, the tortoiſe, and the crocodile. The fecundity of all other animals compared with theſe is ſterility itſelf. Theſe bring forth above two hundred at a time; but, as the offspring is more numerous, the parental care is leſs exerted. Thus the numerous brood of eggs are, without farther ſolicitude, buried in the warm ſands of the ſhore, and the heat of the ſun alone is left to bring them to perfection. To this perfection they arrive almoſt as ſoon as diſengaged from the ſhell. Moſt of them, without any other guide than inſtinct, immediately make to the water. In their paſſage thither, they have numberleſs enemies to fear. The birds of prey that haunt the ſhore, the beaſts that accidentally come that way, and even the animals that give them birth are known, with a ſtrange rapacity, to thin their numbers as well as the reſt.

But it is kindly ordered by Providence, that theſe animals which are moſtly noxious, ſhould thus have many deſtroyers; were it not for this, by their extreme fecundity, they would ſoon over-run the earth, and cumber all our plains with deformity.

END OF THE FIRST VOLUME.